SMITHSONIAN INSTITUTION LIBRARIES

SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES
SMITHSONIAN INSTITUTION LIBRARIES

# PROCEEDINGS

of the

# Biological Society of Washington

VOLUME 88
1975–1976

WASHINGTON
PRINTED FOR THE SOCIETY

EDITOR

AUSTIN B. WILLIAMS

ASSOCIATE EDITORS

*Classical Languages*
GEORGE C. STEYSKAL

*Insects*
ROBERT D. GORDON

*Invertebrates*
THOMAS E. BOWMAN

*Vertebrates*
WILLIAM R. TAYLOR

---

All correspondence should be addressed to the
Biological Society of Washington, Smithsonian Institution
Washington, D. C. 20560

---

ALLEN PRESS INC.
LAWRENCE, KANSAS 66044

# OFFICERS AND COUNCIL

of the

# BIOLOGICAL SOCIETY OF WASHINGTON

**FOR 1975–1976**

## OFFICERS

*President*
CLYDE J. JONES

*Vice President*
CLYDE F. E. ROPER

*Secretary*
W. DUANE HOPE

*Treasurer*
OLIVER S. FLINT

*Custodian of Publications*
JOHN H. MILES

## COUNCIL

*Elected Members*

BRUCE B. COLLETTE
MAUREEN E. DOWNEY
RICHARD S. COWAN
HORTON H. HOBBS, JR.
PAUL J. SPANGLER

TABLE OF CONTENTS

Volume 88

Abele, Lawrence G. A new species of freshwater shrimp (genus *Atya*) from the Pacific drainages of Panamá ..... 51–58

Allen, Gerald R., and Roger Lubbock. *Glyphidodontops springeri*, a new species of damselfish (Pomacentridae) from the Philippine and Mollucca Islands ..... 345–350

Barnard, J. Laurens, and Margaret M. Drummond. Classification of five genera of Phoxocephalidae (marine Amphipoda) ..... 515–548

Baumann, Richard W. A report on the Fifth International Symposium on Plecoptera ..... 399–428

Bogan, Michael, and Clyde Jones. Observations on *Lepus callotis* in New Mexico ..... 45–50

Bouchard, Raymond W., and Judith W. Bouchard. *Orconectes saxatilis*, a new species of crayfish from eastern Oklahoma ..... 439–446

Bouchard, Raymond W., and Judith W. Bouchard. *Orconectes etnieri*, a new species of crayfish from western Tennessee and northern Mississippi with notes on *Procambarus ablusus* and *Orconectes wrighti* ..... 459–468

Bowman, Thomas E., and Charlotte Holmquist. *Asellus* (*Asellus*) *alaskensis*, n. sp., the first Alaskan *Asellus*, with remarks on its Asian affinities (Crustacea: Isopoda: Asellidae) 59–72

Bowman, Thomas E., and Glenn Longley. Redescription and assignment to the new genus *Lirceolus* of the Texas troglobitic water slater, *Asellus smithii* (Ulrich) (Crustacea: Isopoda: Asellidae) ..... 489–496

Bradley, J. Chester. Dates of publication of Westwood's Arcana Entomologica ..... 91–94

Chace, Fenner A., Jr. Cave shrimps (Decapoda: Caridea) from the Dominican Republic ..... 29–44

Child, C. Allan. The Pycnogonida types of William A. Hilton. I. Phoxichilidiidae ..... 189–210

Crabill, R. E., Jr. A new *Watophilus* from Utah, including a list of all known species (Chilopoda: Geophilomorpha: Chilenophilidae) ..... 395–398

Cressey, Roger F. *Shiinoa elagata*, a new species of parasitic copepod (Cyclopoida) from *Elagatus* (Carangidae) ..... 433–438

Dawson, C. E., and J. E. Randall. Notes on Indo-Pacific pipefishes (Pisces: Syngnathidae) with description of two new species ..... 263–280

Deevey, Georgiana B. Two new species of *Bathyconchoecia* (Myodocopa Halocyprididae) from the Caribbean Sea ..... 141–158

Etnier, David A. *Percina* (*Imostoma*) *tanasi*, a new percid fish from the Little Tennessee River, Tennessee ..... 469–488

Ferrari, Frank D. Taxonomic notes of the genus *Oncaea* (Copepoda: Cyclopoida) from the Gulf of Mexico and northern Caribbean Sea ..... 217–232

Fink, William L. A new genus and species of characid fish from the Bayano River basin, Panamá (Pisces: Cypriniformes) ..... 331–344

Fraser, Thomas H., and John E. Randall. Two new Indo-West Pacific cardinalfishes of the genus *Apogon* ..... 503–508

Gore, Robert H., and Linda J. Becker. Studies on stomatopod Crustacea of the Indian River region of Florida. I. Rediscovery and extension of range of *Heterosquilla armata* (Smith, 1881) ..... 21–28

Harman, Walter J. A new species of *Stephensoniana* (Oligochaeta: Naididae) from North America ..... 1–4

Harman, Walter J., and Michael L. McMahan. A reevaluation of *Pristina longiseta* (Oligochaeta: Naididae) in North America ..... 167–178

Heyer, W. Ronald. *Adenomera lutzi* (Amphibia: Leptodactylidae), a new species of frog from Guyana ..... 315–318

Hobbs, Horton H., Jr., and Margaret Walton. New entocytherid ostracods from Tennessee with a key to the species of the genus *Ascetocythere* ..... 5–20

Hoffman, Richard L. A new genus and species of euryurid millipeds from Chiapas (Polydesmida: Platyrhacidae) ..... 211–216

Kenk, Roman. Freshwater triclads (Turbellaria) of North America. VIII. *Dugesia arizonensis*, new species ..... 113–120

Knutson, Lloyd. Key to subfamilies of robber flies based on pupal cases, with a description of the pupal case of *Doryclus distendens* (Asilidae: Megapodinae) ..... 509–514

Kornicker, Louis S., and Marcia Bowen. *Sarsiella ozotothrix*, a new species of marine Ostracoda (Myodocopina) from the Atlantic and Gulf coasts of North America ..... 497–502

Lynch, John D. A new high Andean slope species of *Eleutherodactylus* (Amphibia: Leptodactylidae) from Colombia and Ecuador ..... 351–354

Manning, Raymond B. *Eurysquilla pacifica*, a new stomatopod crustacean from New Britain ..... 249–252

Manning, Raymond B. Two new species of the Indo-West Pacific genus *Chorisquilla* (Crustacea, Stomatopoda), with notes on *C. excavata* (Miers) ..... 253–262

Oliver, Michael K. *Labidochromis textilis*, a new cichlid fish (Teleostei: Cichlidae) from Lake Malawi ..... 319–330
Olson, Storrs L. A new species of *Milvago* from Hispaniola, with notes on other fossil caracaras from the West Indies (Aves: Falconidae) ..... 355–366
Pettibone, Marian H. Review of the genus *Hermenia*, with a description of a new species (Polychaeta: Polynoidae: Lepidonotinae) ..... 233–248
Ray, Clayton E. The relationships of *Hemicaulodon effodiens* Cope 1869 (Mammalia: Odobenidae) ..... 281–304
Rickner, Jack A. Notes on members of the family Porcellanidae (Crustacea: Anomura) collected on the east coast of Mexico 159–166
St. John, Harold. More variants of *Scaevola taccada* (Goodeniaceae) Hawaiian plant studies 43 ..... 73–76
Schwartz, Albert, and Ronald I. Crombie. A new species of the genus *Aristelliger* (Sauria: Gekkonidae) from the Caicos Islands ..... 305–314
Schwartz, Albert, and Richard Franz. A new species of *Sphaerodactylus* (Sauria: Gekkonidae) from Hispanola ..... 367–372
Schwartz, Albert, and Orlando H. Garrido. A reconsideration of some Cuban *Tropidophis* (Serpentes, Boidae) ..... 77–90
Segun, A. O. Two new genera of eudrilid earthworms from Nigeria ..... 383–394
Shelley, Rowland M. The identity of *Nannaria conservata* Chamberlin, with notes on an abnormal male and descriptions of two new species of *Nannaria* from North Carolina (Diplopoda: Polydesmida: Xystodesmidae) ..... 179–188
Shelley, Rowland M. Two new diplopods of the genus *Polyzonium* from North Carolina, with records of established species (Polyzoniida: Polyzoniidae) ..... 373–382
Thomas, Lowell P. The ophiacanthid genus *Amphilimna* (Ophiuroidea, Echinodermata) ..... 127–140
Voss, Gilbert L. Two new species of octopods of the genus *Graneledone* (Mollusca: Cephalopoda) from the Southern Ocean ..... 447–458
Watling, Les. *Parametopella inquilinus*, new species from Delaware Bay oyster beds (Amphipoda: Stenothoidae) ..... 429–432
Watling, Les, and Don Maurer. *Chiridotea stenops* Menzies and Frankenberg, a juvenile of *C. arenicola* Wigley (Crustacea: Isopoda) ..... 121–126
Wetzel, Ralph M. The species of *Tamandua* Gray (Edentata, Myrmecophagidae) ..... 95–112

# BIOLOGICAL SOCIETY OF WASHINGTON

# PROCEEDINGS

## 1049th Meeting—12 March 1975

## NINETY-SIXTH ANNUAL MEETING

The meeting was called to order by President Thomas E. Bowman at 2:05 p.m. in the Baird Auditorium of the National Museum Natural History. Twenty-six members attended.

Reading of the minutes of the previous annual meeting was dispensed with, since they were printed in the Biological Society of Washington Proceedings.

Treasurer Oliver Flint read the Financial Report and Budget for 1975 (attached copy). He pointed out that only $1500 of the original $7000 borrowed from the endowment fund remains to be returned, and that some of the endowment fund has been used to purchase high-interest certificates. The report was accepted by motion.

Mr. C. A. Child, member of the Financial Committee, reported that the Financial Report had been audited and found to be correct.

President Bowman reported that the Council for the Society had held two meetings during the year. In one of the meetings it had been necessary to raise the dues for membership in the Society from $6.00 to $7.00, and to increase slightly the charges for reprints of papers published in the Proceedings.

Austin Williams, Chairman of the Editorial Committee, presented a report stating that Volume 87 of the Proceedings for 1974 consisted of 43 papers totaling 500 pages. Twenty-eight of these were paid, four partially paid and three were unpaid. The first issue of Volume 88, consisting of 11 papers totaling 112 pages, is now in galley proof. Seven of these papers are paid, one partially paid, and three unpaid. Sixteen manuscripts have been received and are under review. Of these, three are paid, seven unpaid, and six have an uncertain status still to be negotiated. In Volume 87 of 1974, biological groupings of papers published were: botany 1; insects 7; invertebrates 18 (crustaceans 11, other 7); vertebrates 17 (fishes 6, amphibians 4, reptiles 3, fossil birds 1, mammals 2).

Secretary Louis S. Kornicker gave results of the election for Officers and Council members for 1975: President, Clyde J. Jones; Vice President, Clyde F. E. Roper; Secretary, W. Duane Hope; Treasurer, Oliver S. Flint; Members of the Council: Bruce B. Collette, Richard S. Cowan, Maureen E. Downey, Horton H. Hobbs, Jr., Paul J. Spangler.

President Bowman then turned over the meeting to the incoming

Secretary, W. Duane Hope. The incoming President and Vice-President were unable to attend the meeting.

Meredith L. Jones made a motion thanking the Officers and Council members of the Society for their efforts on the behalf of the Society for the preceding year. The motion was seconded and passed.

A motion to adjourn at 2:50 p.m. was made, seconded and passed.

Louis S. Kornicker
Secretary

3

QH
1
B4X
NH

SMITHSONIAN
APR 30 1975
LIBRARIES

. 1, pp. 1–4 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# A NEW SPECIES OF *STEPHENSONIANA* (OLIGOCHAETA: NAIDIDAE) FROM NORTH AMERICA

By Walter J. Harman
*Department of Zoology, Louisiana State University, Baton Rouge, Louisiana 70803*

Aiyer (1926:139) described *Naidium* (?) *trivandranum* as a new species from soft mud in an old tank in Trivandrum, India. He was able to culture the species and to get some of the specimens to reach sexual maturity. As a result, in 1929, he published an account of its reproductive biology and recognized the generic distinctiveness of the species. In that paper (1929:27), he described *Stephensonia* as a new genus and placed *S. trivandrana* in it as the only species.

Černosvitov (1938:536), in his report on the oligochaetes of Palestine, found *S. trivandrana* in the waters of Lake Huleh. He correctly pointed out (1938:539) that *Stephensonia* had previously been used in the Aphidae and had priority. He therefore proposed the name *Stephensoniana.*

Brinkhurst (1966:142) recorded *S. trivandrana* from small coastal rivers in the Republic of South Africa.

A generic description, slightly modified in view of the new species, is presented.

*Stephensoniana* Černosvitov, 1938

No eyes. No proboscis. Dorsal setae beginning in II. Hairs and needles, either simple or bifid. Ventral setae all of one type. No coelomocytes. Foreign matter adhering to cuticle.

**Stephensoniana tandyi** n. sp.

*Distribution*: Louisiana; Catahoula Parish. 2.4 mi. NE of the parish line on Louisiana Highway 28. 26 March 1966. Known only from the type locality.

*Holotype*: U. S. National Museum Number 45431 (1 specimen).

Fig. 1. *Stephensoniana tandyi* n. sp.: A, Ventral seta of VI; B, Dorsal needle seta of X.

*Paratypes*: LSU Number 746 (3 specimens).

*Description*: Dorsal setae beginning in II, containing 1 or 2 hairs and 1 bifid needle (Fig. 1). Ventral setae 1 or occasionally 2 per bundle (Fig. 1). Posterior one third of body without setae. Clitellum in VII–IX. Foreign matter adhering to cuticle.

*Discussion*: This species is considered as a member of *Stephensoniana* and not *Pristina* because of the adhering foreign matter, the single ventral seta that makes up most of the ventral bundles, and the little differentiation between anterior and posterior setal morphology. It is distinct from *S. trivandrana* in its possession of bifid needles, fewer setae in all bundles, and in the presence of so great an asetigerous zone at the posterior of the body.

Often, the coat of foreign matter made it difficult or impossible to see the proximal ends of the setae in freshly prepared material. The points of insertion of setae in these specimens, mounted in synthetic resin, did not become apparent until some months after preparation.

Hair setae, 1 or occasionally 2 per bundle, are shorter anteriorly and posteriorly than in midbody. In II, hair setae range from 107 to 124 $\mu$; in VII, 115–186 $\mu$; in XVI, 44–100 $\mu$. The hairs do not appear to be serrated and are fine in structure, about 1 $\mu$ in diameter.

Needle setae are nearly straight and have a very inconspicuous nodulus. They are only slightly more than 1 $\mu$ in diameter. The bifid condition is new to the genus. The distal tooth is about 4 $\mu$ in length, twice as long as the proximal, and is slightly thicker. Needles are 35 to 74 $\mu$ long, longer in midbody than at either end.

Ventral setae, 50 to 81 $\mu$, resemble the needles. A slightly distal nodulus is inconspicuous but visible in II and III. If a nodulus is present in more posterior setae, it is not visible because of the coat of foreign matter. One can be certain that there is not a distal nodulus because one-half of each seta is extended from the body wall. There is no conspicuous difference in shape of seta or tooth structure from anterior to posterior. The distal tooth is over 4 $\mu$ long and twice as long as the proximal.

A clitellum is judged to be present in one specimen because of a great change in body diameter. This enlargement covers part or all of VII, VIII, and IX. The diameter of the body in IV is 112 $\mu$, changing in VII to 187 $\mu$. The coat of foreign matter keeps one from seeing all cell structure to confirm the clitellum. Neither could internal anatomy be observed.

A characteristic of S. *tandyi* is the asetigerous posterior third of the body. Four specimens are available for study. Segments VII, XI, XVI, and XVII contained the last setae. Asetigerous portions of the body were 663 $\mu$, 649 $\mu$, 687 $\mu$, and 374 $\mu$ in length, respectively. The greatest distance between setal bundles in midbody was 60 $\mu$. Assuming the same segmental size for the posterior of the body, there would be from 6 to 11 asetigerous segments. This would be a minimal number, because the pre-periproct segments frequently are small. Therefore, the range of number of segments per worm conservatively is estimated to be 17–28.

The habitat of S. *tandyi* is a low and swampy portion of Catahoula Parish, Louisiana. It is likely that the species is more widely distributed than the collecting data would indicate. There are many intermittent streams present, and surface water may cover much land area following rains, allowing easy distribution between drainage systems, but resulting in discontinuous distribution during the dry season.

S. *tandyi* adds a second species to the previously monotypic genus and establishes it in the fauna of North America.

It is a pleasure to name this species for Dr. Richard E. Tandy who collected it during the study of other forms of Oligochaeta. Dr. John P. O'Neill drew the setal illustrations.

## Literature Cited

Aiyer, K. S. P. 1926. Notes on the aquatic Oligochaeta of Tranvancore. II. Ann. Mag. Nat. Hist. Ser. 9. 18:131–142.

———. 1929. An account of the Oligochaeta of Travancore. Rec. Ind. Mus. 31:13–76.

Brinkhurst, R. O. 1966. A contribution towards a revision of the aquatic Oligochaeta of Africa. Zool. Afr. 2:131–166.

Černosvitov, L. 1938. The Oligochaeta, p. 535–550. *In* R. Washbourn and R. F. Jones, Report of the Percy Sladen Expedition to Lake Huleh; a contribution for the study of the fresh waters of Palestine. Ann. Mag. Nat. Hist. Ser. 11. 2:517–560.

QH
1
B4X
NH

2, pp. 5–20 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# NEW ENTOCYTHERID OSTRACODS FROM TENNESSEE WITH A KEY TO THE SPECIES OF THE GENUS *ASCETOCYTHERE*

By Horton H. Hobbs, Jr., and Margaret Walton
*Smithsonian Institution, Washington, D.C. 20560 and*
*Mountain Lake Biological Station, Pembroke, Virginia 24136*

During a survey of the crayfishes of Tennessee, Raymond W. Bouchard (at present Postdoctoral Fellow, Smithsonian Institution) saved the sediments from the containers that he was using to preserve the specimens caught, and these were donated to us. From these sediments, the branchiobdellids (now in the collection of Perry C. Holt, Virginia Polytechnic Institute and State University), entocytherids, and copepods were retrieved, and the descriptions of new entocytherids included here are largely based on specimens obtained by Dr. Bouchard. Additional material was contributed by Dr. Holt.

Included among the descriptions herein are four new members of the genus *Ascetocythere* (together with a key to the 15 members of the genus), two species of the genus *Dactylocythere*, and one species assigned to a new genus, *Psittocythere*.

We are most grateful to Drs. Bouchard and Holt for donating these specimens to us, and we wish to thank Fenner A. Chace, Jr., Margaret A. Daniel, and C. W. Hart, Jr., for their criticisms of the manuscript.

## *Ascetocythere* Hart, 1962

In order to encompass the new species, *Ascetocythere veruta*, the diagnosis of the genus offered by Hobbs and Hobbs (1970:3) must be emended as follows (The altered portion is in italics.): "Terminal tooth of mandible pectinate. Male copulatory complex without finger guard; peniferum extending ventrally much beyond clasping apparatus, elongate, comparatively slender, with subterminal bulbous enlargement bearing one to several projections; *penis with gap between dorsal spermatic and*

*ventral prostatic elements along part of its length except in A. veruta, and distal portion directed anteriorly, anteroventrally, or posteroventrally*; both elements always shorter than clasping apparatus; accessory groove lacking. Clasping apparatus well developed and may or may not be clearly divisible into vertical and horizontal rami; external border of horizontal ramus entire, internal border with 2, 3, or no teeth along apical half, if present, often grouped far distally with 3 apical denticles. Triunguis female lacking pectinate process on distal podomere of second antenna; genital complex consisting of genital papilla but lacking J-shaped rod and amiculum."

KEY TO THE SPECIES OF THE GENUS *ASCETOCYTHERE*
(Modified from Hobbs and Hobbs, 1970:3)

| | |
|---|---|
| 1 | Penis with contiguous spermatic and prostatic elements ..... *A. veruta*, new species |
| 1′ | Penis with gap between spermatic and prostatic elements along part of its length ..... 2 |
| 2(1′) | Preaxial (internal) border of distal half of clasping apparatus with one or more teeth situated proximal to apical denticles, or preaxial border unarmed (Asceta Group) ..... 3 |
| 2′ | Preaxial (internal) border of clasping apparatus with teeth and apical denticles grouped distally (Coryphodes Group) ..... 14 |
| 3(2) | Bulbous portion of peniferum with well-developed anterior process ..... 4 |
| 3′ | Bulbous portion of peniferum lacking anterior process ..... 12 |
| 4(3) | Ventral portion of peniferum with angular flange ..... 5 |
| 4′ | Ventral portion of peniferum lacking angular flange ..... 7 |
| 5(4) | Flange on ventral portion of peniferum subtriangular ..... *A. bouchardi*, new species |
| 5′ | Flange on ventral portion of peniferum subrectangular ..... 6 |
| 6(5′) | Ventral extremity of peniferum with fingerlike projection extending ventrally beyond angular flange ..... *A. asceta* (Hobbs and Walton, 1962:39) |
| 6′ | Ventral extremity of peniferum lacking fingerlike projection ..... *A. ozalea* Hobbs and Hart, 1966:40 |
| 7(4′) | Ventral portion of peniferum with posterior process ..... 8 |
| 7′ | Ventral portion of peniferum lacking posterior process ..... 10 |
| 8(7) | Anterior process triangular, broadly fused basally with ventral process ..... *A. triangulata*, new species |
| 8′ | Anterior process slender and elongate, distinctly set off from digitiform ventral process ..... 9 |
| 9(8′) | Anterior process of peniferum much shorter than ventral (digitiform) process and situated on level above base of penis ..... *A. sclera* Hobbs and Hart, 1966:42 |
| 9′ | Anterior process of peniferum as long as ventral (digitiform) process and situated on level below base of penis ..... *A. holti* Hobbs and Walton, 1970:853 |

10(7′) Peniferum with tablike penis guide extending anterodorsally from mesial side of ventral process ..... *A. pseudolita*, new species

10′ Peniferum lacking tablike penis guide ..... 11

11(10′) Postaxial (external) border of clasping apparatus with proximal bend at end of proximal fifth of apparatus; penis reaching posterior surface of digitiform process ..... *A. lita* Hobbs and Hobbs, 1970:4

11′ Postaxial (external) border of clasping appartus with proximal bend at end of proximal third of apparatus; penis extending along anterior side of digitiform process ..... *A. batchi* Hobbs and Walton, 1968:237

12(3′) Ventral portion of peniferum lacking angular flange ..... *A. didactylata* Hobbs and Hart, 1966:43

12′ Ventral portion of peniferum with angular flange ..... 13

13(12′) Ventral portion of peniferum with distinct curved digitiform (ventral) process extending posteroventrally from flange ..... *A. hoffmani* Hobbs and Hart, 1966:40

13′ Ventral portion of peniferum lacking distinct digitiform (ventral) process ..... *A. hyperoche* Hobbs and Hart, 1966:41

14(2′) Anterior surface of subterminal or terminal enlargement of peniferum with anteroventrally projecting, clublike prominence and two additional prominences ..... *A. cosmeta* Hobbs and Hart, 1966:46

14′ Anterior surface of terminal enlargement of peniferum with single prominent snoutlike projection ..... 15

15(14′) Snoutlike prominence less than half as long as longitudinal diameter of peniferum at level of prominence ..... *A. myxoides* Hobbs and Hart, 1966:45

15′ Snoutlike prominence more than two-thirds as long as longitudinal diameter of peniferum at level of prominence ..... *A. coryphodes* Hobbs and Hart, 1966:44

**Ascetocythere bouchardi**, new species
(Figure 1*a–d*)

*Male*: Eye pigmented (not clearly defined in holotype) and located approximately one-fourth shell length from anterior margin. Shell (Fig. 1*b*) ovate with greatest height one-third length from posterior end where about 1.3 times height at level of eye; margin entire but with slight broad impression ventrally just posterior to level of eye. Submarginal setae present except dorsally, somewhat evenly spaced ventrally but closer together anterodorsally and posteroventrally.

Copulatory complex (Fig. 1*a*) with bulbous portion of peniferum bearing following processes: anterior process short (length about one-sixth diameter of peniferum at base), thick, rounded distally, and directed anteriorly; ventral process very complex, consisting of broad winglike

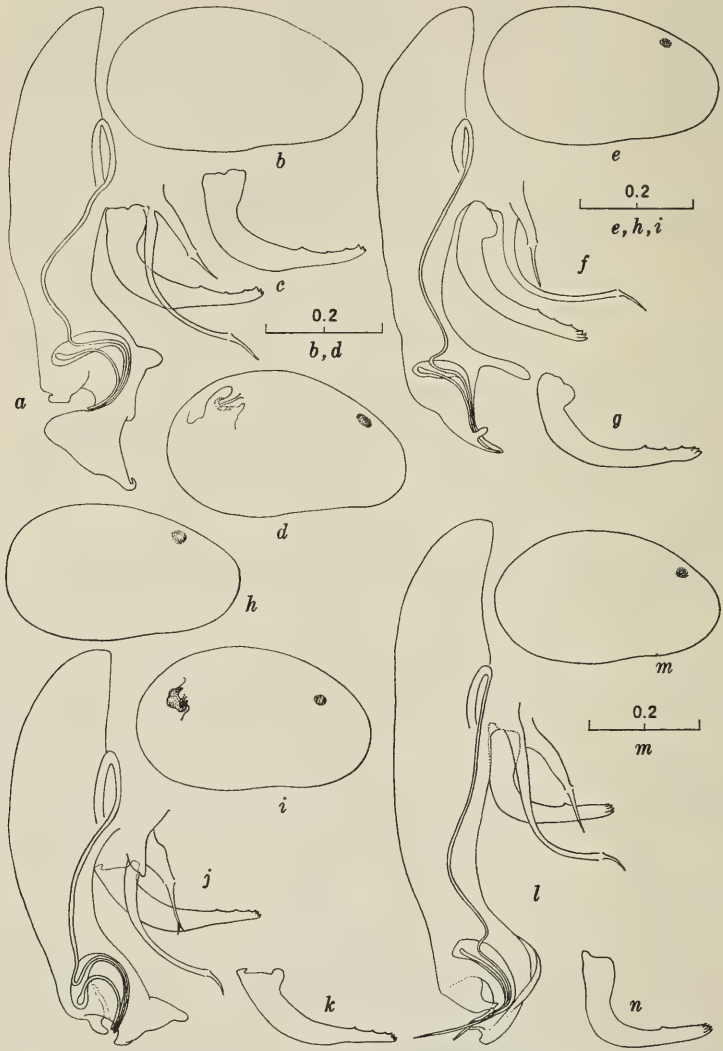



FIG. 1*a–d*, *Ascetocythere bouchardi*, new species; 1*e–g*, *Ascetocythere pseudolita*, new species; 1*h–k*, *Ascetocythere triangulata*, new species; 1*l–n*, *Ascetocythere veruta*, new species. *a*, *f*, *j*, *l*, coplatory complex of male; *b*, *e*, *h*, *m*, dextral view of shell of male; *c*, *g*, *k*, *n*, clasping apparatus of male; *d*, *i*, dextral view of shell of triunguis female. Scales in mm.

lobe supporting terminal anteroventral digitiform, ventromesially directed projection and small flange projecting anteromesially from cephalic base of process; and posterior process consisting of short subrectangular lobe on posteroventral angle of bulbous area. Penis very prominent, C-shaped, with apex reaching posterodorsal base of flange of ventral process. Clasping apparatus (Fig. 1*c*) not reaching level of midlength of bulge of peniferum, L-shaped, with margins of very short, broad, tapering vertical ramus entire; horizontal ramus with almost uniform diameter along proximal third, tapering in middle third, and with subparallel dorsal and ventral margins in distal third; internal border of distal half with 3 equally spaced teeth, and apex with 3 terminal denticles. Dorsal finger moderately heavy and about one-half as long as slender ventral finger; latter slender and evenly curved posteroventrally almost from base.

*Triunguis Female*: Eye pigmented and situated approximately one-fifth shell length from anterior margin. Shell (Fig. 1*d*) subpyriform, highest slightly posterior to midlength, greatest height approximately 1.5 times height at level of eye. Submarginal setae disposed as in male. Genital complex consisting of short posteroventrally directed papilla with heterogeneous mass adhering to apical part.

*Measurements* (*in mm*): 5 males and 5 females.

| | Holotype | Males | Allotype | Females |
|---|---|---|---|---|
| Length (range) | 0.43 | 0.43–0.46 | 0.42 | 0.42–0.47 |
| Average | | 0.44 | | 0.44 |
| Height (range) | 0.25 | 0.25–0.27 | 0.27 | 0.25–0.28 |
| Average | | 0.26 | | 0.26 |

*Type-locality*: Soddy Creek off County Road 5306, southwest of Hendon, approximately 0.3 mile north of the Sequatchie County line, Bledsoe County, Tennessee, where it was infesting the stream-dwelling *Cambarus* (*Jugicambarus*) *parvoculus* Hobbs and Shoup, 1947, and *Cambarus* (*Jugicambarus*) sp. nov.

*Disposition of Types*: The holotypic male and allotypic female are deposited in the National Museum of Natural History (Smithsonian Institution), numbers 150640 and 150641, respectively. Paratypes are in the collection of H. H. Hobbs III and the Smithsonian Institution.

*Range and Specimens Examined*: Tweny-two specimens from the following localities in Tennessee: Type-locality; Renfro Creek at U.S. Highway 70, northwest of Ozone, Cumberland County; Duskin Creek at County Road 5881, northeast of Milo, Bledsoe County; and Cain Creek, tributary of North Chickamauga Creek, off road between County Road 4264 and U.S. Highway 27, southeast of Dunlap, Sequatchie County.

*Hosts*: *Cambarus* (*Jugicambarus*) *parvoculus* Hobbs and Shoup, 1947, *Cambarus* (*Hiaticambarus*) *longirostris* Faxon, 1885, and *Cambarus* (*Jugicambarus*) sp. nov.

*Entocytherid Associates*: *Dactylocythere pachysphyrata* Hobbs and Walton, 1966, *Donnaldsoncythere hiwasseensis* (Hobbs and Walton, 1961).

*Relationships*: *Ascetocythere bouchardi* has its closest affinities with *Ascetocythere asceta* (Hobbs and Walton, 1962) and, more distantly, is related to *A. hoffmani* Hobbs and Hart, 1966, and *A. ozalea* Hobbs and Hart, 1966. The flattened flange on the ventral end of the peniferum, the caudally curved penis, and 3 teeth on the preaxial border of the horizontal ramus of the clasping apparatus will distinguish *A. bouchardi* from all of its congeners.

*Etymology*: This ostracod is named in honor of its discoverer, Raymond W. Bouchard, who also collected and donated to us most of the specimens on which this report is based.

**Ascetocythere pseudolita**, new species

(Figure 1*e–g*)

*Male*: Eye pigmented and located one-fourth shell length from anterior margin. Shell (Fig. 1*e*) egg-shaped, with greatest height slightly posterior to midlength and 1.4 times height at level of eye. Margin entire but with faint broad ventral excavation short distance anterior to midlength. Submarginal setae present except posterodorsally; setae slightly closer together anteriorly and posteriorly than ventrally.

Copulatory complex (Fig. 1*f*) with usual ventral bulbous area bearing anteriorly directed, slender, slightly curved anterior process; ventral surface of bulbous area produced in conical, gently procurved ventral process bearing tablike penis guide mesially. Penis also curved and following contour of mesial longitudinal groove almost to apex of process. Clasping apparatus (Fig. 1*g*) not nearly reaching ventral margin of peniferum, not clearly divisible into horizontal and vertical rami but with subangular bend proximally and gently tapering distally; preaxial margin bearing 1 small tooth at base of distal third and 2 additional ones evenly spaced between it and 3 apical denticles. Dorsal finger slightly less than half as long as gently curved ventral finger, latter with bend similar although not subparallel to contour of clasping apparatus.

*Female*: Unknown.

*Measurements*: Holotypic male (only known specimen) 0.41 mm long and 0.24 mm high.

*Type-locality*: Laurel Branch off U.S. Highway 25W, northwest of La Follette, Campbell County, Tennessee, where it was found in company with *Donnaldsoncythere hiwasseensis* (Hobbs and Walton, 1961) and *Dactylocythere spinata* Hobbs and Walton, 1970. These were retrieved from a collection of crayfishes containing *Cambarus* (*Jugicambarus*) *distans* Rhoades, 1944, and *Cambarus* (*Puncticambarus*) *buntingi* Bouchard, 1973.

*Disposition of Types*: The holotypic male is deposited in the National Museum of Natural History (Smithsonian Institution), number 150642.

*Range and Specimens Examined*: The holotype is the only known specimen.

*Hosts and Entocytherid Associates*: See "Type-locality."

*Relationships*: *Ascetocythere pseudolita*, as its name suggests, shares more in common with *Ascetocythere lita* Hobbs and Hobbs, 1970, than with any other species. The most striking similarities exist in the terminal elements of the peniferum and the armature of the clasping apparatus. The most conspicuous differences are in the curvature of the clasping apparatus which approaches that of *A. asceta* (Hobbs and Walton, 1962) and in the presence of the tablike penis guide directing the penis toward the distal extremity of the ventral process rather than posteroventrally.

**Ascetocythere triangulata**, new species
(Figure 1*h–k*)

*Male*: Eye pigmented and located about one-fourth shell length from anterior margin. Shell (Fig. 1*h*) subovate with greatest height about one-third shell length from posterior margin, there about 1.3 times height at level of eye; ventral margin with shallow excavation anterior to mid-length. Submarginal setae present except dorsally; setae somewhat closer together anteriorly and posteriorly than ventrally.

Copulatory complex (Fig. 1*j*) with ventral subbulbous area bearing prominent broadly based subtriangular cephalic process (whence the specific name), posteroventral margin of which poorly delimited from greatly reduced, slightly recurved ventral process; posterior process small, thumblike, procurved, and opposing posterior margin of ventral process. Penis U-shaped and emerging from body of peniferum between ventral and posterior processes. Clasping apparatus (Fig. 1*k*) not nearly reaching ventral extremity of peniferum and not divisible into horizontal and vertical rami; apparatus curved in proximal half, almost straight in distal half, and gently tapering almost from base to 3 terminal denticles; preaxial margin bearing 3 teeth on distal third, with penultimate tooth closer to ultimate than to antepenultimate. Dorsal finger stouter than ventral and approximately half as long; ventral finger gently curved caudoventrally from base.

*Triunguis Female*: Eyes situated as in male. Shell (Fig. 1*i*) more highly vaulted than in male but with greatest height also about 1.3 times that at level of eye; concavity on ventral margin more strongly pronounced than in male. Submarginal setae disposed as in male.

Genital complex consisting of single or bilobed prominence surrounded by heterogeneous, amorphous, slightly refractile mass situated posterodorsally.

*Measurements* (*in mm*): 2 males and 2 females.

| | Holotype | Male | Allotype | Female |
|---|---|---|---|---|
| Length | 0.41 | 0.42 | 0.41 | 0.41 |
| Height | 0.22 | 0.23 | 0.25 | 0.25 |

*Type-locality*: Pole Bridge Branch (Caney Fork River System), tributary to Lost Creek at County Road 4385, south of De Rossett, White County, Tennessee. There it was associated with *Donnaldsoncythere hiwasseensis* (Hobbs and Walton, 1961), *Dactylocythere* sp., and *Entocythere illinoisensis* Hoff, 1942. These ostracods were obtained from a collection of crayfishes containing *Cambarus* (*Depressicambarus*) *sphenoides* Hobbs, 1968, and *C.* (*Jugicambarus*) *parvoculus* Hobbs and Shoup, 1947.

*Disposition of Types*: The holotypic male and allotypic female are deposited in the National Museum of Natural History (Smithsonian Institution), number 150643 and 150644, respectively, as are the paratypic male and female.

*Range and Specimens Examined*: Known only from the type-locality. The four specimens in the type-series are the only known specimens.

*Hosts and Entocytherid Associates*: See "Type-locality."

*Relationships*: *Ascetocythere triangulata* has its closest affinities with members of the Asceta Group of the genus, and shares more in common with *A. holti* Hobbs and Walton, 1970, than with any other species. It may be distinguished from all members of the genus by the anterior process of the peniferum which is subtriangular with its broad base situated on the anterodistal margin of the peniferum. Three teeth on the preaxial border of the clasping apparatus will also distinguish this species from *A. holti.*

**Ascetocythere veruta**, new species
(Figure 1*l–n*)

*Male*: Eye pigmented and located slightly anterior to anterior fourth of shell length from anterior margin. Shell (Fig. 1*m*) almost egg-shaped with greatest height short distance posterior to midlength where about 1.4 times higher than shell at level of eye; ventral margin with shallow concavity anterior to midlength. Submarginal setae present except dorsally and posterodorsally; setae only little closer together anterodorsally and posteroventrally than elsewhere.

Copulatory complex (Fig. 1*l*) with ventral subbulbous area lacking cephalic process but bearing thin shelflike obliquely vertical flange on cephalic margin, ventral part extending onto prominent posteroventrally curved ventral process; latter bifid distally with more posterodistal lobe supporting penis; posterior process consisting of short, strongly sclerotized, clawlike projection situated posterodorsal to ventral process and with apex directed anteriorly. Penis unique in genus, its prostatic and spermatic elements being contiguous rather than separated for some distance; both elements emerging free from distal extremity of posterior lobe of bifid ventral process. Clasping apparatus (Fig. 1*n*) L-shaped with horizontal ramus noticeably slenderer (slightly tapering) than vertical ramus and bearing single tooth on preaxial surface slightly distal

to midlength; ramus terminating in 4 apical denticles. Both dorsal and ventral fingers rather slender, former little more than half length of latter; ventral finger straight along proximal third and gently curved caudally to base of apical seta.

*Female*: Unknown.

*Measurements*: Holotypic male (only known specimen) 0.41 mm long and 0.24 mm high.

*Type-locality*: Poplar Creek (Tennessee River System) on road between Tennessee routes 115 and 61, in Laurel Grove, Anderson County, Tennessee, where it was found associated with *Dactylocythere falcata* (Hobbs and Walton, 1961), and *Donnaldsoncythere hiwasseensis* (Hobbs and Walton, 1961). It was infesting either *Cambarus* (*Hiaticambarus*) *longirostris* Faxon, 1885, or *C.* (*Jugicambarus*) *distans* Rhoades, 1944.

*Disposition of Type*: The holotypic male is deposited in the National Museum of Natural History (Smithsonian Institution), number 150645.

*Range and Specimens Examined*: Known only from the type-locality; the holotype is the only specimen available.

*Host and Entocytherid Associates*: See "Type-locality."

*Relationships*: *Ascetocythere veruta* is not closely allied to any known entocytherine. The general conformation of the peniferum resembles that of members of the Asceta Group of the genus more closely than those of other members of the subfamily, and the clasping apparatus is strikingly similar to that of *Ascetocythere lita* Hobbs and Hobbs, 1970, but differs in that only 1 tooth is present on the preaxial margin. The contiguous condition of the spermatic and prostatic elements of the penis, as stated above, is unique in the genus, as are the posteroventrally directed ventral process and the heavily sclerotized clawlike posterior process. The latter is suggestive of the posteroventral, sometimes movable, clawlike projection in the Microsyssitrinae and some Notocytherinae. (See Hart, Nair, and Hart, 1967, and Hart and Hart, 1967.)

## *Dactylocythere* Hart, 1962

The two new members of the genus *Dactylocythere* described below may be included in the key to the members of that genus provided by Hobbs and Hobbs (1970:6) by inserting the following:

| | | |
|---|---|---|
| 12(7′) | Dorsal margin of accessory groove not reaching beyond midlength of spermatic loop | 13a |
| 12′ | Dorsal margin of accessory groove reaching almost to, or slightly beyond, dorsal extremity of spermatic loop | 16 |
| 13a(12) | Preaxial (internal) border of horizontal ramus of clasping apparatus with 2 or more teeth or emarginations; tip of penis not nearly reaching level of posteroventral extremity of peniferum | 13 |
| 13a′ | Preaxial (internal) border of horizontal ramus of clasping apparatus never with more than 1 (sometimes without) | |

tooth and it adjacent to apical denticles; tip of penis reaching level of posteroventral extremity of peniferum 30

30(13a') Ventral surface of peniferum almost straight; peniferal groove conspicuous; anteroventral protuberance of peniferum lacking ..... *Dt. scissura*, new species

30' Ventral surface of peniferum curved; peniferal groove lacking; peniferum bearing anterovental, slightly tapering, truncate protuberance ..... *Dt. crena*, new species

**Dactylocythere crena**, new species

(Figure 2*a–f*)

*Male*: Eye pigmented, located approximately one-third to one-fourth shell length from anterior margin. Shell (Fig. 2*d*) oblong ovate, produced posteroventrally in broad rounded lobe. Submarginal setae around entire perimeter, somewhat evenly dispersed except anterodorsally and posteroventrally where closer together. Sternal spine lacking.

Copulatory complex (Fig. 2*a*) with rather short, somewhat tapering, distally bifid finger guard; peniferum robust with small, rounded posteroventral lobe bearing delicate anteroventral and somewhat mesial sheath-like protuberance, latter broader at base than distally; peniferal groove not evident. Penis L-shaped with distal arm subequal in length to proximal arm, conspicuously longer than that of all other congeners except *Dactylothere scissura* (see below), and extending well into anteroventral protuberance of peniferum. Accessory groove slender, extending posterodorsally from base of penis, variable in length but rarely reaching level of ventral extremity of spermatic loop. Clasping apparatus (Fig. 2*c*) extending ventrally beyond ventral extremity of peniferum, somewhat L-shaped with rami joined in rather abrupt curve; vertical ramus almost straight with both pre- and postaxial margins entire; horizontal ramus subequal in length to vertical ramus, very gently curved dorsally from base to apex, its margins entire, and terminating in 3 or 4 small denticles. Dorsal and ventral fingers slender, latter about twice length of former and with proximal third to half straight, distal portion curved gently caudally.

*Triunguis Female*: Eye pigmented, situated slightly posterior to anterior fourth of shell. Shell (Fig. 2*e*) tapering anteriorly, 1.5 times as high posteriorly as at level of eye. Posterior margin of shell with conspicuous, often subrectangular, notch (from whence the name *crena*, L. = notch) height of which approximately one-fourth to one-fifth greatest height of shell. Genital complex (Fig. 2*b*) situated at fundus of notch consisting of vertically disposed sinus encompassing slightly curved hyalin rod (probably corresponding to "J-shaped rod" of most congeners) in dorsal half and tubular cavity with posteroventral angle ventrally. No trace of amiculum present.

*Measurements (in mm)*: 10 males and 10 females.

| | Holotype | Males | Allotype | Females |
|---|---|---|---|---|
| Length (range) | 0.68 | 0.61–0.69 | 0.69 | 0.61–0.70 |
| Average | | 0.67 | | 0.65 |
| Height (range) | 0.35 | 0.33–0.37 | 0.34 | 0.34–0.42 |
| Average | | 0.35 | | 0.39 |

*Type-locality*: Field off County Road 2428, (Tennessee River Basin), southeast of Martel near Cedar Hills Golf Course, Loudon County, Tennessee, where this ostracod was infesting an undescribed burrowing crayfish, *Cambarus* (*Depressicambarus*) sp.

*Disposition of Types*: The holotypic male and allotypic female are deposited in the National Museum of Natural History (Smithsonian Institution), number 150646 and 150647. Paratypes are in the collection of H. H. Hobbs III and the Smithsonian Institution.

*Range and Specimens Examined*: Approximately 175 specimens from the type-locality and immediate vicinity (Tennessee River Basin).

*Hosts*: *Cambarus* (*Lacunicambarus*) *diogenes* subsp. and *Cambarus* (*Depressicambarus*) sp.

*Entocytherid Associates*: *Uncinocythere simondsi* Hobbs and Walton, 1960, *Cymocythere gonia* Hobbs and Hart, 1966, and *Dactylocythere* sp.

*Relationships*: *Dactylocythere crena* has its closest affinities with *Dt. scissura* (described below). They share a longer ventral arm of the penis than other species of the genus, and the females of both possess a deep notch in the caudal margin of the shell. This species may be distinguished from *Dt. scissura* by its larger size, in possessing a rounded, as opposed to almost straight, anteroventral margin of the peniferum, and the penis opens into an anteroventral sheathlike projection from the lobe.

**Dactylocythere scissura**, new species
(Figure 2*g–k*)

*Male*: Eye pigmented, located slightly posterior to anterior fifth of shell. Shell (Fig. 2*g*) oblong ovate with slight broadly rounded posteroventral bulge. Submarginal setae around entire perimeter of shell, somewhat evenly distributed except anterodorsally and posteroventrally where closer together. Sternal spine absent.

Copulatory complex (Fig. 2*i*) with short to moderately long trifid finger guard; peniferum moderately robust with posteroventral extremity subangular and with almost straight ventral margin forming, in optical section, acute anteroventral angle. Peniferal groove distinct, opening anteroventrally, its diameter about half that of least diameter of vertical ramus of clasping apparatus. Penis L-shaped with distal arm distinctly

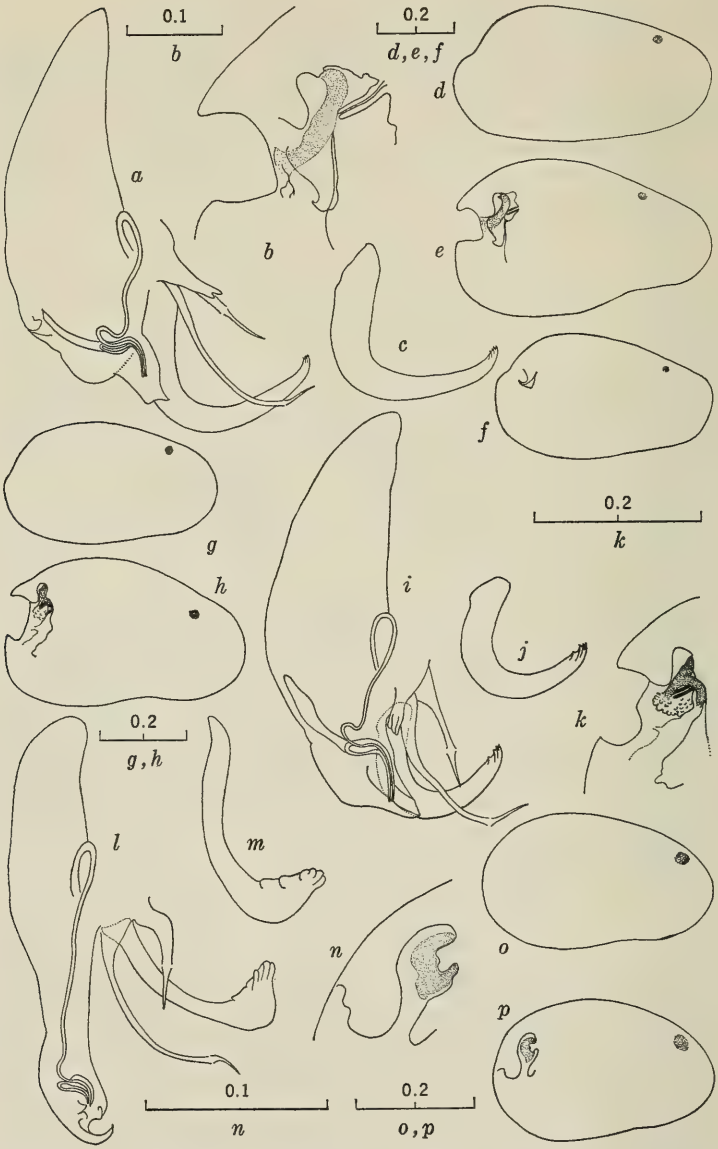



FIG. 2*a–f*, *Dactylocythere crena*, new species; 2*g–k*, *Dactylocythere scissura*, new species; 2*l–p*, *Psittocythere psitta*, new species. *a*, *i*, *l*, copulatory complex of male; *b*, *k*, *n*, genital apparatus of female; *c*, *j*, *m*, clasping apparatus of male; *d*, *g*, *o*, dextral view of shell of male; *e*, *h*, *p*, dextral view of shell of triunguis female; *f*, dextral view of shell of biunguis female. Scales in mm.

longer than proximal arm; distal arm proportionately longer than that of any other of its congeners and sometimes reaching almost to distal extremity of peniferal groove. Accessory groove slender, extending posterodorsally from base of penis, never reaching dorsally beyond level of midlength of spermatic loop. Clasping apparatus (Fig. 2*j*) C-shaped without hint of angle at junction of horizontal and vertical rami; rami subequal in length; vertical ramus entire, and horizontal ramus with 3 apical denticles and 1 small tooth immediately proximal to latter. Dorsal and ventral fingers moderately slender, former slightly greater than half length of latter; ventral finger weakly sinuous and directed anteroventrally.

*Triunguis Female*: Eye pigmented, situated approximately one-fourth shell length from anterior margin. Shell (Fig. 2*h*) very high posteriorly and tapering anteriorly, greatest height about 1.4 times that at level of eye. Posterior margin of shell with broad subrectangular notch (suggesting the name *scissura*, L. = cleft), height of which about one-third greatest height of shell. Genital complex (Fig. 2*k*) consisting of highly refractive J-shaped rod with tapering, dorsally disposed extension from body of rod; heterogeneous frothy-appearing mass suspended from ventral extremity of refractive body opposite cleft in posterior margin of shell, this body perhaps corresponding, at least in position, to amiculum of most members of genus.

*Measurements* (*in mm*): 10 males and 10 females.

| | Holotype | Males | Allotype | Females |
|---|---|---|---|---|
| Length (range) | 0.50 | 0.48–0.53 | 0.53 | 0.49–0.55 |
| Average | | 0.50 | | 0.52 |
| Height (range) | 0.28 | 0.27–0.29 | 0.31 | 0.29–0.35 |
| Average | | 0.28 | | 0.32 |

*Type-locality*: Field at Ten Mile Creek (Tennessee River Basin) at U.S. Highway 11, Knox County, Tennessee, where it was infesting an undescribed burrowing crayfish, *Cambarus* (*Depressicambarus*) sp.

*Disposition of Types*: The holotypic male and allotypic female are deposited in the National Museum of Natural History (Smithsonian Institution), numbers 150648 and 150649, respectively. Paratypes are in the collection of H. H. Hobbs III and the Smithsonian Institution.

*Range and Specimens Examined*: Approximately 30 specimens from the following localities in the Tennessee River Basin, Knox County, Tennessee: Field at County Road 2404, Middlebrook Pike, opposite Wesley Road, Knoxville. Field at Interstate 75 N, near Emory Road eastern exit, Knoxville. Field at Hardin Valley Road, approximately 2 miles southwest of Lovell Road off Interstate 40, west of Ball Camp. Field southwest of Byrd Chapel, just west of Hickory Creek.

*Hosts*: *Cambarus* (*Depressicambarus*) sp. nov., *Cambarus* (*Cam-*

*barus*) *bartonii bartonii* (Fabricius, 1798), and *Cambarus* (*Jugicambarus*) *dubius* Faxon, 1884.

*Entocytherid Associates*: *Donnaldsoncythere hiwasseensis* (Hobbs and Walton, 1961), *Uncinocythere simondsi* (Hobbs and Walton, 1960), *Dactylocythere* sp., and *Entocythere* sp.

*Relationships*: *Dactylocythere scissura* is more closely related to *Dt. crena* than to any other ostracod. The unique characteristics of the two are pointed out in the discussion of relationships of the latter. *Dactylocythere scissura* may be distinguished from *Dt. crena* by its smaller size, the presence of a well defined peniferal groove instead of a tapering anteroventral sheath on the peniferum, and the former possesses a ventrally flattened peniferum as opposed to a ventrally rounded one in *Dt. crena*.

**Psittocythere**, new genus

*Diagnosis*: Terminal tooth of mandible pectinate. Male copulatory complex (Fig. 2*l*) without finger guard. Peniferum extending ventrally only slightly beyond clasping apparatus, elongate, slender, with subterminal enlargement bearing single acute hooklike projection from posteroventral extremity; hook curved anterodorsally; penis consisting of contiguous spermatic and prostatic elements directed anteroventrally, neither element more than one-fourth length of clasping apparatus; accessory groove lacking. Clasping apparatus (Fig. 2*m*) not reaching ventral margin of peniferum but well developed, clublike, and not clearly divisible into horizontal and vertical rami; postaxial border entire; preaxial border of swollen distal third with 6 rounded teeth. Triunguis female with second antenna lacking accessory pectinate process on distal podomere; genital complex (Fig. 2*n*) consisting of short bilobed prominence, suspended in posterodorsal part of body, surrounded by amorphous irregularly shaped refractive mass.

*Type-species*: *Psittocythere psitta*, described below.

*Gender*: Feminine.

**Psittocythere psitta**, new species
(Figure 2*l–p*)

*Male*: Eye pigmented and located about one-sixth shell length from anterior margin. Shell (Fig. 2*o*) subovate with greatest height distinctly posterior to midlength, about 1.5 times height at level of eye; ventral margin with faint concavity anterior to midlength. Submarginal setae present except dorsally and somewhat closer together anteriorly and posteriorly than ventrally.

Copulatory complex (Fig. 2*l*) as described in generic diagnosis. In addition, dorsal finger distinctly angular and slightly more than half length of slender, gently and evenly curved ventral process.

*Triunguis Female*: Eye as in male. Shell (Fig. 2*p*) more highly vaulted than in male, with greatest height distinctly posterior to mid-

length, about 1.7 times that of height at level of eye; ventral margin with concavity as in male. Submarginal setae present except dorsally between level of eye and genital complex, distinctly closer together anteriorly and posteriorly than ventrally.

*Measurements (in mm)*: 7 males and 5 females.

| | Holotype | Males | Allotype | Females |
|---|---|---|---|---|
| Length (range) | 0.39 | 0.38–0.40 | 0.37 | 0.37–0.42 |
| Average | | 0.39 | | 0.40 |
| Height (range) | 0.23 | 0.20–0.23 | 0.24 | 0.22–0.25 |
| Average | | 0.22 | | 0.23 |

*Type-locality*: Laurel Creek, 9.7 miles northeast of Jamestown on State Route 154, Fentress County, Tennessee. There this ostracod was associated with *Dactylocythere spinata* Hobbs and Walton, 1970, and *Donnaldsoncythere hiwasseensis* (Hobbs and Walton, 1961). These ostracods were infesting *Cambarus* (*Jugicambarus*) *distans* Rhoades, 1944.

*Disposition of Types*: The holotypic male and allotypic female are deposited in the National Museum of Natural History (Smithsonian Institution), number 150650. Paratypes are in the collection of H. H. Hobbs III and the Smithsonian Institution.

*Range and Specimens Examined*: Known from the type-locality and the following two localities in Pickett County, Tennessee: Rock Creek at State Route 154, and Thompsons Creek at State Route 154. Only 12 specimens are available from the three localities, all of which are in the Big South Fork of the Cumberland River system.

*Host*: *Cambarus* (*Jugicambarus*) *distans* Rhoades, 1944.

*Entocytherid Associates*: *Dactylocythere spinata* Hobbs and Walton, 1970, *Donnaldsoncythere hiwasseensis* (Hobbs and Walton, 1961), *Dactylocythere* sp., and *Entocythere* sp.

*Relationships*: *Psittocythere psitta* is perhaps more closely allied to *Cymocythere clavata* Crawford, 1965, than to any other species, the greatest similarity occurring in the clasping apparatus. In this respect, however, it is markedly dissimilar to the other two species assigned to the latter genus. The arched hooklike projection anterodorsally from the posteroventral side of the subterminal bulbous area is unique in this ostracod, and it is this unique characteristic that lends a parrotlike aspect to the inverted peniferum that, in turn, suggested the generic and specific names proposed for this ostracod.

## Literature Cited

(References to descriptions of crayfishes are omitted; these may be found in Hobbs, Horton H., Jr. 1974. A Checklist of the North and

Middle American Crayfishes (Decapoda: Astacidae and Cambaridae). Smithsonian Contrib. Zool. 166:1–161, 294 figs.)

Crawford, Edward A., Jr. 1965. Three new species of epizoic ostracods (Ostracoda, Entocytheridae) from North and South Carolina. Amer. Midl. Nat. 74(1):148–154, 16 figs.

Hart, C. W., Jr. 1962. A revision of the ostracods of the family Entocytheridae. Proc. Acad. Nat. Sci. Philad. 114(3):121–147, 18 figs.

———, and Dabney G. Hart. 1967. The entocytherid ostracods of Australia. Proc. Acad. Nat. Sci. Philad. 119(1):1–51, 95 figs.

———, A. Balakrishnan Nair, and Dabney G. Hart. 1967. A new ostracod (Ostracoda: Entocytheridae) commensal on a wood-boring marine isopod from India. Notulae Naturae, Acad. Nat. Sci. Philad. 409:1–11, 17 figs.

Hobbs, Horton H., Jr., and C. W. Hart, Jr. 1966. On the entocytherid ostracod genera *Ascetocythere*, *Plectocythere*, *Phymocythere* (gen. nov.), and *Cymocythere*, with descriptions of new species. Proc. Acad. Nat. Sci. Philad. 118(2):35–61, 37 figs.

———, and H. H. Hobbs III. 1970. New entocytherid ostracods with a key to the genera of the subfamily Entocytherinae. Smithsonian Contrib. Zool. 47:1–19, 9 figs.

———, and Margaret Walton. 1960. Three new ostracods of the genus *Entocythere* from the Hiwassee Drainage System in Georgia and Tennessee. Journ. Tenn. Acad. Sci. 35(1):17–23, 20 figs.

———. 1961. Additional new ostracods from the Hiwassee Drainage System in Georgia, North Carolina, and Tennessee. Trans. Amer. Micros. Soc. 80(4):379–384, 8 figs.

———. 1962. New ostracods of the genus *Entocythere* from the Mountain Lake region, Virginia (Ostracoda, Entocytheridae). Virginia Journ. Sci., new series 13(2):42–48, 12 figs.

———. 1966. A new genus and six new species of entocytherid ostracods (Ostracoda, Entocytheridae). Proc. U.S. Nat. Mus. 119(3542):1–12, 2 figs.

———. 1968. New entocytherid ostracods from the southern United States. Proc. Acad. Nat. Sci. Philad. 120(6):237–252, 3 figs.

———. 1970. New entocytherid ostracods from Tennessee and Virginia. Proc. Biol. Soc. Wash. 82(68):851–863, 3 figs.

Hoff, C. Clayton. 1944. New American species of the ostracod genus *Entocythere*. Amer. Midl. Nat. 32(2):327–357, 33 figs.

QH
1
B4X
NH

3, pp. 21–28 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# STUDIES ON STOMATOPOD CRUSTACEA OF THE INDIAN RIVER REGION OF FLORIDA. I. REDISCOVERY AND EXTENSION OF RANGE OF *HETEROSQUILLA ARMATA* (SMITH, 1881)[1]

By Robert H. Gore and Linda J. Becker
*Smithsonian Institution, Ft. Pierce, Florida 33450*

*Heterosquilla armata* (Smith) is an uncommon species of mantis shrimp in the family Lysiosquillidae which was originally described in 1881 from material obtained primarily by the U.S. Fish Commission Steamer "Fish Hawk" off the coast of New England (see Manning, 1969: 52). In spite of numerous collections by many agencies in the waters off the northeastern United States and elsewhere along the eastern seaboard, apparently only one additional specimen has been taken. This specimen, a female, was captured in 1963 by the National Marine Fisheries Service from 128 m on the margin of the continental slope east of New Jersey. The range of the species thus seemed to be confined to waters off the New England area and vicinity in depths from 96–218 m (Manning, 1974: 4).

It was of considerable interest, then, to find a single female specimen of *H. armata* in collections which we had made on the continental shelf off the central eastern Florida coast. This rediscovery was deemed of sufficient interest to warrant a short report at this time.

We thank Dr. Raymond B. Manning and Thomas E. Bowman, National Museum of Natural History, for critically reading the manuscript. Dr. Manning also confirmed our identification of the species, and provided the data on the one other recently collected specimen. Dr. Roland Wigley, National Marine Fisheries Service Laboratory (NMFS), Woods Hole, Massa-

[1] Scientific Contribution No. 36 from the Smithsonian Institution-Harbor Branch Foundation Consortium, Science Laboratories.

chusetts, graciously allowed one of us (LJB) to examine and measure this specimen, and provided additional information on its collection. Photographs of the Floridan and New England specimen are by Mr. William Davenport, Harbor Branch Foundation Laboratory, Ft. Pierce, Florida.

*Materials and Methods*: Our system of measurements follows that of Manning (1969) except for total length (TL) which was measured along the dorsal midline from rostral tip to tip of the spines on the boss of the telson. All measurements were made with a Wild M-5 stereomicroscope using an ocular reticle and a stage micrometer, and were rounded off to the nearest tenth of a millimeter. Research vessel cruise numbers are followed by station number.

For complete synonymies the reader is referred to Manning's (1969) monograph on western Atlantic Stomatopoda. We include in this report only the citations of the original author, and subsequent changes and additions in the generic and subgeneric nomenclature.

*Heterosquilla* (*Heterosquilloides*) *armata* (Smith, 1881)

Figures 1–3

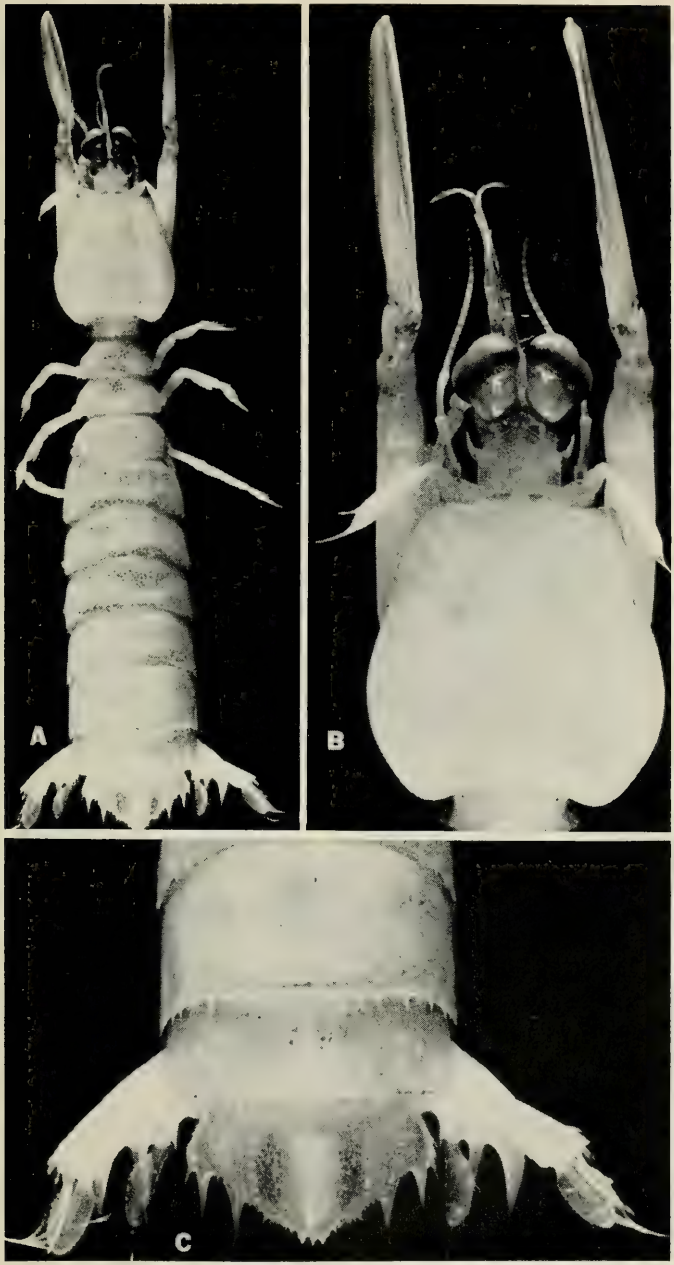
*Lysiosquilla armata* Smith, 1881: 446.—Manning, 1963: 321 [listed].
*Heterosquilla* (*Heterosquilloides*) *armata*.—Manning, 1963: 321 [listed]; 1966: 119, 124 [listed]; 1969: 44, 45, 52, fig. 11a, b; 1974: 1, 3, 4, fig. 7, 9 [listed, key].

*Material examined*: 1 ♀, cl 12.0 mm, TL 72.4 mm, R/V Albatross IV, 63–7/166, 39°26′N, 72°25′W, 128 m, 36′ otter trawl, 11 December 1963. 1 ♀, cl 7.4 mm, TL 42.8 mm, R/V Gosnold 237/507, 27°08.5′N, 79°54′W, 210 m, 5′ Blake trawl, 11 June 1974.

*Remarks*: The New England specimen had been examined previously and its identification confirmed by Dr. R. B. Manning. The single Floridan specimen available for examination agreed well with the description and illustration provided by Manning (1969: 52) and with the male lectotype deposited in the National Museum of Natural History. In our specimen, the median projection of the telson was much more noticeably raised than would be inferred from R. P. Bigelow's illustration

→

Fig. 1. *Heterosquilla armata* (Smith), Florida specimen, dorsal views: A, Whole animal. B, Carapace. C, Posterior abdominal somites and telson.


A
B
C

as used by Manning. In addition, the lectotype and other material in the National Museum exhibited a more distinct telsonal boss than the recently collected New England specimen. We also noted minor variation in the number and shape of the dorsal and marginal spines on the telson in the Floridan specimen (i.e. more sharply pointed) when compared with the above mentioned material but consider this variation to be nonsignificant (see Figs. 1c, 2c). We compared our specimen with all available material (much of which was in poor shape) deposited in the National Museum of Natural History (USNM 7199, 21491), and found no other notable differences.

*Color*: The color of the Floridan specimen after two months in alcohol was as follows. The animal is grayish-white overall with a fine network of brown chromatophores scattered over the body. The rostrum is brown anteriorly, becoming lighter at the suture with the carapace. The carapace has 2 brown spots anterolaterally, plus 4 spots on the gastric grooves, 2 of which occur on the posterior parts of the grooves, followed by 2 medially near the posterior margin of the carpace. The thoracic somites have brown chromatophores as follows: fifth somite, 2 small single "snowflake" dots on the anterolateral margin; somites 6–8, scattered brown specks posteriorly, becoming less numerous anteriorad, so that a clear margin appears to be present in unmagnified view. Abdominal somites 1–3 have alternating transverse bands of grayish-white anteriorly, and brown posteriorly, on each somite; somite 4 dorsolaterally with 2 subparallel transverse bands of brown, becoming off-white medially; somites 5 and 6 similar to somites 1–3. The telson has a row of scattered brown chromatophores laterally along the longitudinal margin of the raised median boss as far as the first row of transverse spinules. The carpus and merus of the raptorial claws, the antennules, the antennal peduncles, and the eyestalks all have numerous scattered brown chromatophores.

*Measurements*: New England female, TL 72.4, carapace length by width (cl × cw) 12.0 × 11.1, cornea width 3.6, rostral carapace length (Rcl) 16.2, rostral length by width (Rl × Rw) 3.3 × 3.6, width of abdominal somite 5 (A-5w) 14.5, telson length by width (tl × tw) 7.7 × 12.2 mm.—Florida female, TL 42.8, cl × cw 7.4 × 7.5, cornea width 2.4, Rcl 9.5, Rl × Rw 2.1 × 2.0, A-5w 7.9, tl × tw 4.0 × 6.8 mm.

*Distribution*: Off New England in waters 96–218 m depth. The Floridan specimen reported herein, collected in 210 m, extends the known range approximately 1400 km southward to a point about 19 km east of St. Lucie Inlet, Martin County, Florida.

---

→

Fig. 2. *Heterosquilla armata* (Smith): A, New England specimen, whole animal, dorsal view. B, Same, posterior abdominal somites and telson, dorsal view. C, Florida specimen, posterior abdominal somite and telson, ventral view.

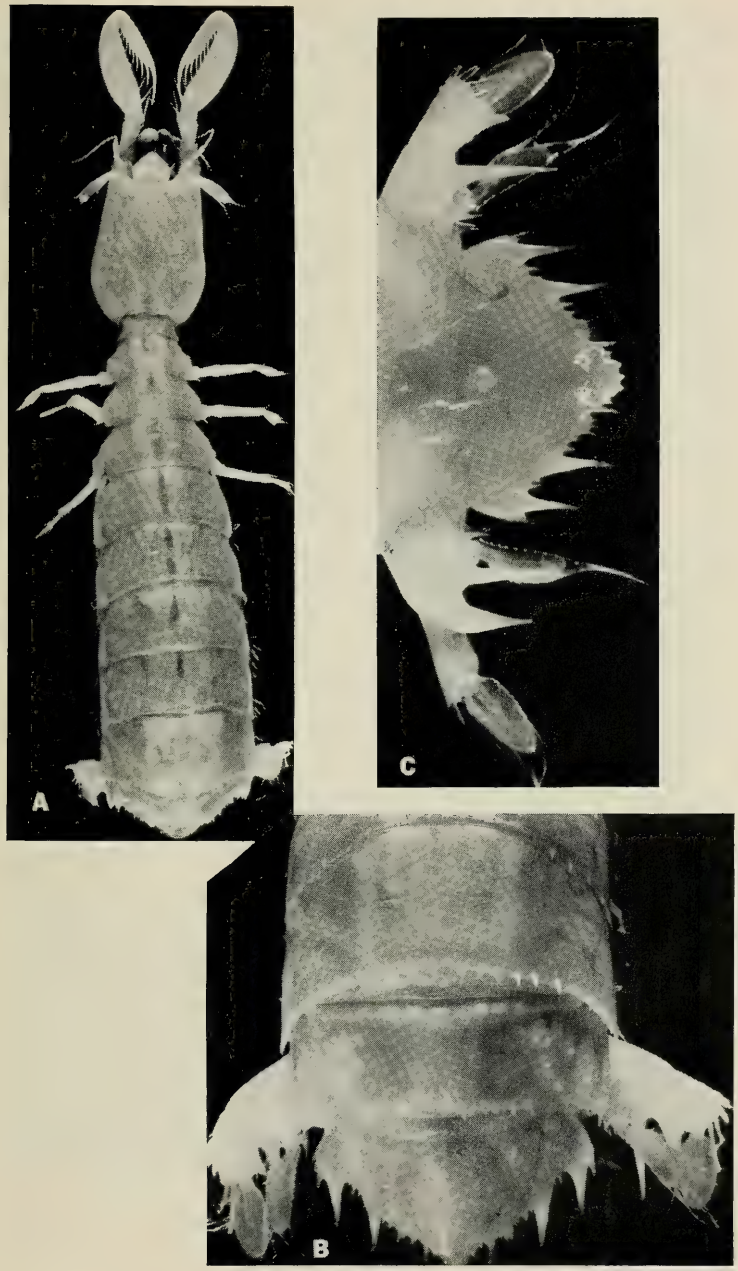

A
C
B

FIG. 3. *Heterosquilla armata* (Smith): A, Florida specimen, right raptoral claw, mesial view. B, New England specimen, anterior part, lateral view.

*Discussion*: Although extensive sampling has been carried out on the continental shelf of central eastern Florida between 27° and 28° N latitude over the past 10 months (November 1973 to August 1974) by the R/V Gosnold, with over 500 biological collection stations occupied, only the single female specimen of *H. armata* has thus far been taken. The Florida record, therefore, may be extralimital. Depth records, including the data on the NMFS specimen and the Floridan specimen, indicate that *Heterosquilla armata* is a species inhabiting deeper waters on the continental shelf. Station records for the U.S.F.C.S. Fish Hawk and Albatross, those from the R/V Albatross IV provided by Dr. Roland Wigley of the NMFS, and the R/V Gosnold data all indicate that *Heterosquilla armata* should be looked for on the distal edge of the continental shelf and upper margins of the continental slope. The tilefish record noted in Manning (1969: 52, 343) was a Fish Hawk station on the continental slope due east of New Jersey.

The presence of *H. armata* as far south as central eastern Florida may be either a reflection of its preferred habitat, i.e. the proximity of the continental slope, or a preference for the cooler oceanic water found along the 200 m line in this vicinity, where temperatures of 10–12°C prevail. Whatever the reason, the rediscovery so far southward of this distinctively ornamented lysiosquillid after an interval of over 90 years simply reinforces the fact that our knowledge of many benthic species and their distribution along the continental shelf still remains incomplete.

The New England specimen has been returned to Dr. Roland Wigley, National Marine Fisheries Service Laboratory, Woods Hole, Massachusetts. The specimen from Florida has been deposited in the National Museum of Natural History, Washington, D.C., USNM 150273.

## Literature Cited

Manning, R. B. 1963. Preliminary revision of the genera *Pseudosquilla* and *Lysiosquilla* with descriptions of six new genera (Crustacea; Stomatopoda). Bull. Mar. Sci. Gulf & Carib. 13(2):308–328.

———. 1966. Notes on some Australian and New Zealand Stomatopod Crustacea, with an account of the species collected by the Fisheries Investigation Ship *Endeavour*. Rec. Australian Mus. 27(4):79–137, figs. 1–10.

———. 1969. Stomatopod Crustacea of the Western Atlantic. Stud. Trop. Oceanogr. Miami 8: viii + 380 pp., figs. 1–91.

———. 1974. Marine flora and fauna of the northeastern United States. Crustacea: Stomatopoda. NOAA Tech. Rpt. NMFS Circ. 387: iii + 6 pp., figs. 1–10.

Smith, S. I. 1881. Preliminary notice of the Crustacea dredged, in 64 to 325 fathoms, off the south coast of New England, by the U.S. Fish Commission in 1880. Proc. U.S. Nat. Mus. 3:413–452.

QH
1
B4X
NH

o. 4, pp. 29–44 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SMITHSONIAN
APR 23 1975

# CAVE SHRIMPS (DECAPODA: CARIDEA) FROM THE DOMINICAN REPUBLIC

By Fenner A. Chace, Jr.
*Smithsonian Institution, Washington, D.C. 20560*

A small but excellently preserved collection of shrimps recently received from Renato O. Rímoli of Santo Domingo, Dominican Republic, contained three specimens of particular interest from subterranean habitats. The first is a species of the atyid genus *Typhlatya* that had been recorded previously from Isla Mona off Puerto Rico and from Barbuda in the Leeward Islands. The second is an apparently undescribed species of the palaemonid genus *Macrobrachium* that shows no obvious adaptation for troglobitic existence. The third is a second species of the recently proposed hippolytid genus *Calliasmata*, the type-species of which is known from anchialine pools (Holthuis, 1973:3) in the Sinai Peninsula, Ellice Islands, and Hawaiian Islands.

I am very grateful to Mr. Rímoli for making this material available to me and for his assistance during the preparation of the paper, as well as to my colleagues, Thomas E. Bowman, Horton H. Hobbs, Jr., Raymond B. Manning, and Austin B. Williams, for their critical review of the manuscript.

## Atyidae

### *Typhlatya monae* Chace

*Typhlatya monae* Chace, 1954:318, fig. 1.—Chace and Hobbs, 1969:80, fig. 16.

*Typhlatya nana* Vandel, 1964:178 (incorrect spelling of *monae*); 1965: 139.

*Material* (carapace lengths in mm in brackets): La Furnia de Los Corrales, Villas del Mar, Provincia de San Pedro de Macoris, Dominican Republic; 16 August 1973; Renato O. Rímoli: 21 ♀ [3.3–4.4].

*Color*: Yellow-orange in life.

*Habitat*: La Furnia de Los Corrales is a subterranean cavity surrounded by abundant vegetation about 400 meters from the sea. The entrance has a maximum height of 1.85 meters, with a cornice one meter thick. The distance to the innermost end of the cavity is 9.20 meters. There is sufficient phreatic water to form a pool about two feet deep, the bottom of which is covered with a large amount of sediment of organic origin. Light penetrates into the interior, providing some illumination, but the presence of the shrimps, which were quite numerous, was detected by flashlight.

*Distribution*: The species has been recorded previously from subterranean fresh water on Isla Mona (Puerto Rico) and Barbuda (Leeward Islands).

*Remarks*: Not even a vestige of an exopod can be found on the fifth pereopods of these specimens. They agree so well, however, with specimens of *T. monae* from Isla Mona and Barbuda in all other characters that there is little justification for regarding them as taxonomically distinct.

Like all previously recorded specimens of the species, none of the series from the Dominican Republic has an appendix masculina on the second pleopods, and all have consequently been presumed to be females. Inasmuch as males of most of the other species of the genus are known—even of the closely related *T. garciai* Chace, 1943, from Cuba—the failure thus far to find males of *T. monae* suggests two possible explanations: either they are unrecognizable from external characters or they are restricted to a habitat niche that has not yet been investigated.

The mysterious presence of part of the type-series of *T. monae* in a concrete water catchment basin on the high central mesa of Isla Mona (Chace, 1954:319) has finally been explained. Thomas A. Wiewandt, who has been conducting an ecological survey of Mona under the auspices of the Puerto Rico Department of Natural Resources, informs me that, during dry periods on the island, water from the wells in which the shrimp normally occurs is sometimes pumped into the catchment basins, thereby accounting for the presence of *Typhlatya* in such an apparently inimical habitat.

### Palaemonidae

### **Macrobrachium crybelum** new species

Figures 1–4

? *Macrobrachium olfersii*.—Rathbun, 1919:324.—Schmitt, 1936:372. [Not *Palaemon olfersii* Wiegmann, 1836.]

? *Macrobrachium* sp. (near *M. faustinum*) Chace and Holthuis, 1948:23.

? *Macrobrachium* aff. *faustinum* Holthuis, 1952:95.

*Description*: Rostrum with dorsal margin usually regularly concave (Fig. 3*a*), rarely straight (Fig. 1*a*), overreaching antennal scale, 0.7 to

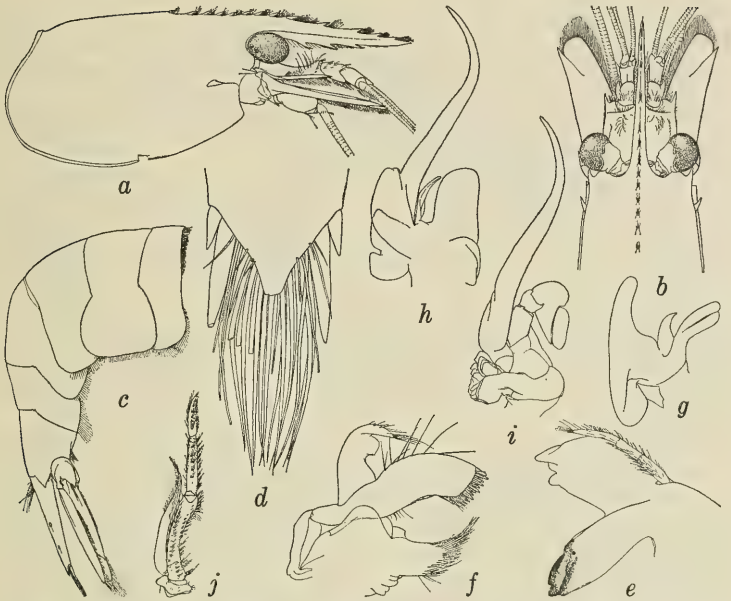



FIG. 1. *Macrobrachium crybelum*, holotype ♂. *a*, Carapace and anterior appendages in lateral aspect; *b*, Anterior region in dorsal aspect; *c*, Abdomen; *d*, Posterior end of telson; *e*, Right mandible; *f*, Right first maxilla; *g*, Right second maxilla; *h*, Right first maxilliped; *i*, Right second maxilliped; *j*, Right third maxilliped. (*a–c*, *j*, × 2; *g–i*, × 4; *e*, *f*, × 8; *d*, × 17.)

0.9 as long as carapace in larger specimens, as long as or slightly longer than carapace in juveniles; armed dorsally with 11 to 16 teeth, including 4 to 6 on carapace posterior to orbit, spaced farther apart on rostrum than on carapace, except anteriormost 2 or 3 occasionally set close together, all but those on anterior half of rostrum with indistinct basal suture; armed ventrally with 3 to 6, most frequently 4, teeth; lateral ridge sharp in posterior ⅔ of length, becoming blunt anteriorly, equidistant from dorsal and ventral margins over much of length.

Carapace smooth, antennal spine arising submarginally from suborbital lobe, somewhat longer than hepatic spine; rather distinct suture extending from base of hepatic spine to anterior margin.

Abdomen smooth, pleuron of 4th somite with posteroventral angle varying from subrectangular (Fig. 3*c*) to rounded (Fig. 1*c*); pleuron of 5th somite acute posteroventrally; 6th somite about 1.5 times as long as 5th, acute posteroventrally, posterolateral lobe drawn out to sharp tooth. Telson about 1.5 times as long as 6th somite, normally

with 2 pairs of distinct dorsal spines, 1 near midlength, 1 about midway between first pair and posterior end of telson; posterior margin (Figs. 1*d*, 3*d*) acutely triangular (obviously damaged in holotype), apex falling far short of tips of larger of 2 pairs of posterior spines.

Eyes (Figs. 1*b*, 3*b*) rather short, cornea inflated and fully pigmented, with ocellus on dorsomesial surface.

Antennular peduncle (Figs. 1*b*, 3*b*) with strong distolateral spine on proximal segment. Lateral flagellum fused for 5 to 10 short articles, mesial branch nearly as long as postorbital length of carapace, lateral branch nearly 3 times as long as carapace; mesial flagellum about twice as long as carapace.

Antennal scale (Figs. 1*b*, 3*b*) about 3 times as long as wide, distolateral spine nearly or quite reaching level of truncate distal margin of blade. Antennal peduncle not reaching midlength of scale, basal segment with strong lateral spine. Flagellum nearly 6 times as long as carapace.

Mouthparts as illustrated (Figs. 1*e–j*, 3*e–j*). Third maxilliped falling slightly to considerably short of distal end of antennal scale.

First pereopod (Figs. 2*a*, 4*a*) overreaching antennal scale by length of chela and about ½ of carpus in holotype, but slightly less than length of chela in some smaller specimens; carpus 1.5 to 2.0 times as long as chela. Fully developed second pereopods distinctly dissimilar and unequal. Major 2nd pereopod (Fig. 2*b*) overreaching antennal scale by length of chela and nearly or more than entire length of carpus; chela (Fig. 2*c*) with fingers slightly shorter than palm; opposable margins of both dactyl and fixed finger with single row of 12 to 17 rounded teeth, one larger than rest near bases of both fingers, distal ones small and indistinct; surface of palm concealed by closely spaced tufts of long fine hairs covering margin continuous with fixed finger and extending far onto both flattened surfaces; long dark setae becoming especially numerous on fingers and forming dense fringe in gape; most of surface covered with distally directed spines increasing in length on fingers and forming distinct row along margin continuous with fixed finger, those centrally located on palm shorter than those on proximal and distal portions; carpus slightly longer than palm and about 1.4 times as long as merus. Minor 2nd pereopod (Fig. 2*d*) more slender, overreaching antennal scale by ½ or nearly entire length of carpus; chela (Fig. 2*e*) with fingers as long as palm; opposable margins of both dactyl and fixed finger with large tooth near bases and 3 minute tubercles proximal thereto, remainder of margins entire and rather sharp; surface of chela with numerous long dark setae becoming crowded on fingers and forming dense fringe in gape; carpus distinctly longer than palm and longer than merus. Third pereopod (Fig. 2*f*) overreaching antennal scale by length of dactyl and about ⅛ of propodus. Fourth pereopod (Fig. 2*g*) overreaching antennal scale by length of dactyl and about ¼ of propodus. Fifth pereopod (Fig. 2*h*) overreaching antennal scale by length of dactyl and about ¼ of propodus.

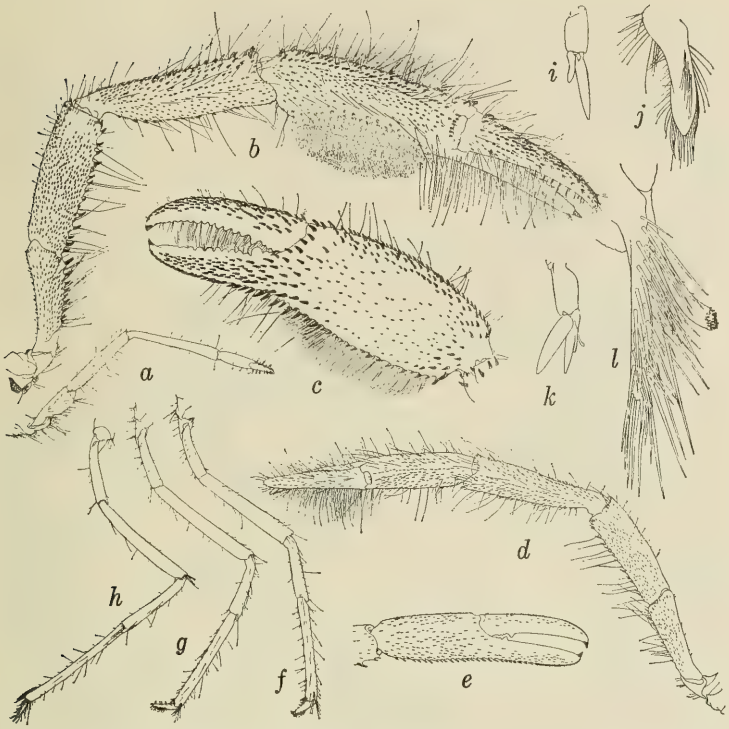



FIG. 2. *Macrobrachium crybelum*, holotype ♂. *a*, Right first pereopod; *b*, Right second pereopod; *c*, Same, extensor aspect of chela (denuded); *d*, Left second pereopod; *e*, Same, extensor aspect of chela (denuded); *f*, Right third pereopod; *g*, Right fourth pereopod; *h*, Right fifth pereopod; *i*, Right first pleopod; *j*, Same, endopod; *k*, Right second pleopod; *l*, Same, appendices interna and masculina. (*a–i*, *k*, × 2; *j*, × 4; *l*, × 17.)

Endopod of first pleopod (Figs. 2*i*, *j*), appendix masculina (Figs. 2*k*, *l*), and uropods characteristic of genus.

*Variation*: In the largest male in the collection—a specimen with a carapace length of 17.8 mm from Cueva de Valiente—the second pair of pereopods (Figs. 4*b*, *c*) are much less dissimilar and less unequal than they are in both the holotype and a similar male with a carapace length of 13.0 mm from the type-locality. In the Cueva de Valiente male, the major cheliped is almost identical with those in two females with carapace lengths of 18.4 and 19.2 mm from La Caleta. The chela is less swollen and less densely furred than in the holotype and the

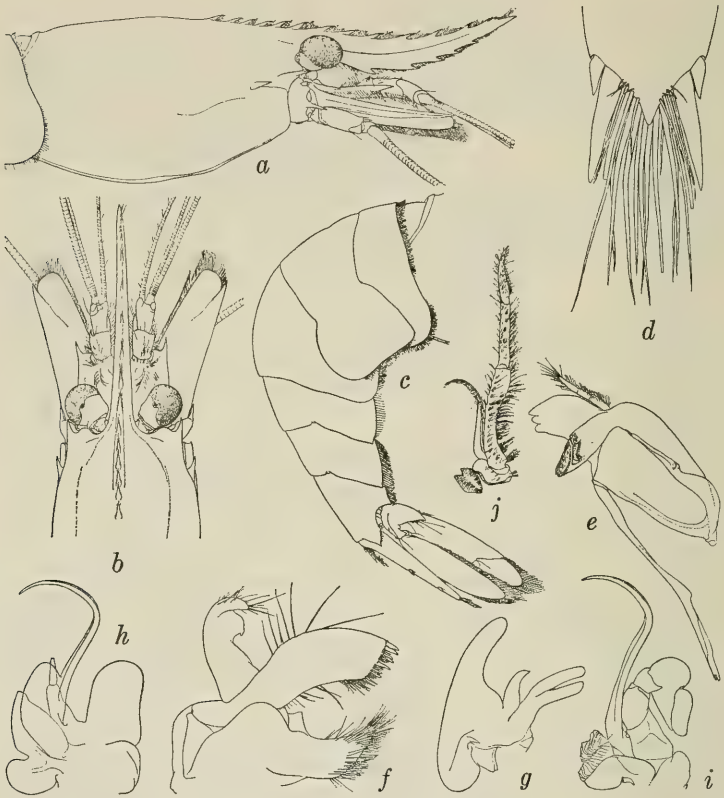



FIG. 3. *Macrobrachium crybelum*, gynecomorphous paratype ♂, carapace length 17.8 mm, from Cueva de Valiente (except *d*). *a*, Carapace and anterior appendages in lateral aspect; *b*, Anterior region in dorsal aspect; *c*, Abdomen; *d*, Posterior end of telson of paratype ♂, carapace length 14.3 mm, from Cueva de Valiente; *e*, Right mandible; *f*, Right first maxilla; *g*, Right second maxilla; *h*, Right first maxilliped; *i*, Right second maxilliped; *j*, Right third maxilliped. (*a–c*, *j*, × 2; *e*, *g–i*, × 4; *f*, × 8; *d*, × 17.)

fingers are proportionately longer and less gaping, with the opposable margins (Fig. 4*e*) armed as in the minor cheliped, lacking teeth on the distal two-thirds of their lengths. Also, the rows of spines on the merus and ischium are much less prominent than the comparable series in the holotype. In all of the specimens except these five (two males from Ciudad del Caribe, one male from Cueva de Valiente, and two females from La Caleta), the second pereopods are more slender, not very dis-

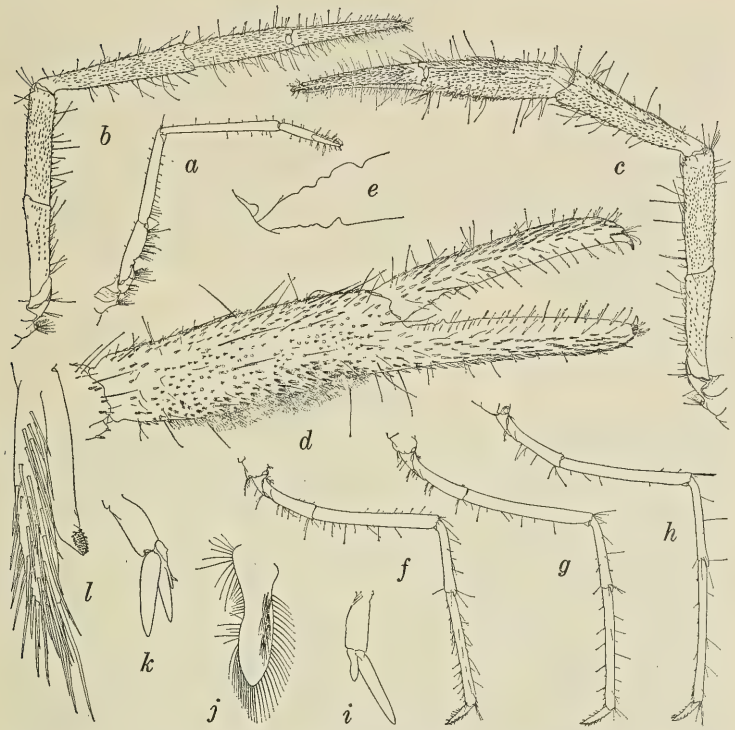



FIG. 4. *Macrobrachium crybelum*, gynecomorphous paratype ♂, carapace length 17.8 mm, from Cueva de Valiente. *a*, Right first pereopod; *b*, Right second pereopod; *c*, Left second pereopod; *d*, Same, chela; *e*, Same, basal teeth of fingers; *f*, Right third pereopod; *g*, Right fourth pereopod; *h*, Right fifth pereopod; *i*, Right first pleopod; *j*, Same, endopod; *k*, Right second pleopod; *l*, Same, appendices interna and masculina. (*a–c*, *f–i*, *k*, × 2; *d*, × 4; *e*, *j*, × 8; *l*, × 17.)

similar, equal or only slightly unequal, and the major chelae are not noticeably furred.

*Size*: Carapace length of holotype male, 14.9 mm; of paratype males, 5.9 to 17.8 mm; of paratype females, 5.6 to 19.2 mm.

*Type-locality*: Cave at Ciudad del Caribe (18°58′N, 70°23′W), Santo Domingo, D.N., Dominican Republic.

*Material* (carapace lengths in mm in brackets): Cave at Ciudad del Caribe, Santo Domingo, D.N., Dominican Republic; 14 July 1973; Renato O. Rímoli: 10 ♂ [7.8–14.9] (largest is holotype, USNM 151199) 5 ♀ [9.6–11.7].—El Caimito (Cave No. 2), Dominican Republic; 17 February 1974; Renato O. Rímoli: 1 ♀ [14.2].—La Caleta, Dominican

Republic; 15 March 1974; Renato O. Rímoli: 2 ♂ [5.9, 11.3] 6 ♀ [5.6–19.2].—"Cueva de Valiente," km 21, Autopista "Las Americas," Santo Domingo, D.N., Dominican Republic; 27 May 1974; Alberto Ottenwalder: 4 ♂ [9.0–17.8] 14 ♀ [8.2–15.5].

*Habitat*: The cave at Ciudad del Caribe is in Pleistocene limestone about 50 meters from the sea and at approximate sea level. The pool within is brackish and varies in depth from one to five feet, with considerable sediment of vegetable origin. The shrimps occurred throughout the pool but seemed to prefer hiding among rocks near the edge. A fish, *Lophogobius cyprinoides*, occupied the same pool and preyed on the shrimps, at least in captivity.

At El Caimito, the pool is situated at the end of a large cave where nearly absolute darkness prevailed. The single specimen taken from this pool was found in shallow water, but the depth varied from a foot to several meters. The bottom is entirely rocky and devoid of organic sediment. The water was almost fresh or very slightly brackish and completely clear—the deeper part blue by flashlight—and with only a slight current. A fish was observed in the pool but it avoided capture. The fauna near the entrance of the cave was scanty, consisting principally of arachnids and lizards (*Anolis*, sp.).

The cave at La Caleta was not completely dark. The water was little brackish and varied in depth from one to 15 feet. An unidentified fish was also found there.

*Name*: The specific name—from krybelos, G., = hidden, secret—was suggested by the habitat.

*Remarks*: Typical mature males of *Macrobrachium crybelum* superficially resemble comparable specimens of *M. faustinum* (De Saussure, 1857), which occurs in exposed freshwater habitats throughout the West Indian islands, but they may be readily distinguished by the following characters. The rostrum is longer, overreaching the antennal scales rather than reaching no farther than the end of the antennular peduncle. The spines on the major second pereopod are more numerous and less erect, especially those on the margins corresponding to that of the fixed finger of the chela. The fixed finger of the minor second pereopod is less bowed, so that the fingers gape less noticeably. The three posterior pairs of pereopods are longer, considerably overreaching the antennal scale, rather than reaching at most only to the distal end of the scale. Specimens of both sexes of *M. crybelum* differ from all other American species of the genus known thus far in the combination of a long rostrum, overreaching the antennal scales, and more than three teeth of the dorsal rostral series situated on the carapace posterior to the orbit.

There is a possibility that the large male from Cueva de Valiente (Figs. 3, 4) and the two large females from La Caleta represent a distinct species, because of the very different form of the major second pereopod. It seems more likely, however, that the females display the normal development of the chelipeds at this size and that the male is gynecomorphous. There are no other distinguishing characters to support

the recognition of a second species. Holthuis (1952:12) noted that in this genus: "Sometimes males may be found, which are as large as males with fully developed second legs, but in which these legs are still shaped like in the females and juveniles." Perhaps regeneration is the cause of this apparent dimorphism.

It is quite conceivable that the specimens from wells on Bonaire, identified by Holthuis (1952:95) as "*Macrobrachium* aff. *faustinum*," belong to this species. The specimens of that material available to me are compatible with that conclusion, but the lack of a male with fully developed second pereopods precludes a positive determination.

HIPPOLYTIDAE

**Calliasmata rimolii**, new species

Figures 5–7

*Description*: Rostrum (Figs. 6*b*, *c*) short and simple, directed anteroventrad and largely concealed by eyes from lateral view; ventral margin sinuous; apex sharply pointed; dorsal aspect narrowly acute, lateral margin passing into orbital margin with broadly rounded obtuse angle.

Carapace (Fig. 5) noticeably inflated dorsally and laterally; surface largely smooth, not closely pitted, without apparent scales but with widely scattered, very short, microscopic setae set perpendicular to surface. Antennal spine (Fig. 6*b*) triangular, curving slightly ventrad, almost imperceptibly separated from orbital margin, distinctly overreaching level of tip of rostrum. Anteroventral margin of carapace broadly rounded. Without cardiac notch posteriorly.

Abdomen (Fig. 5) broadly rounded dorsally; surface largely smooth as on carapace. Pleura of 4 anterior somites broadly rounded, of 5th somite acutely produced posteroventrally. Sixth somite nearly ⅛ again as long as 5th, posteroventral angle bluntly triangular, posterolateral lobe drawn out into narrowly acute, dorsally straight spine (Fig. 6*d*). Telson (Fig. 6*e*) about ½ again as long as 6th somite, slightly less than 2½ times as long as wide, tapering rather regularly to broadly triangular posterior margin armed with distinct median spine; dorsal surface bearing 2 pairs of rather inconspicuous spines, anterior pair placed slightly anterior to midlength, posterior pair about midway between anterior pair and posterior margin; posterior margin (Fig. 6*f*) armed with 3 pairs of movable spines, intermediate pair much the longest and lateral pair much the shortest.

Eyes (Fig. 6*g*) apparently immovably fused together basally, variably divergent or approximate distally, usually slightly overreaching level of tips of antennal spines; somewhat variable in shape, depending on degree of development of subtruncate anteromesial projection; anterolateral margin consisting of rather sharp, broadly rounded flange; rudimentary cornea lateral to base of anteromesial projection; persistent black pig-

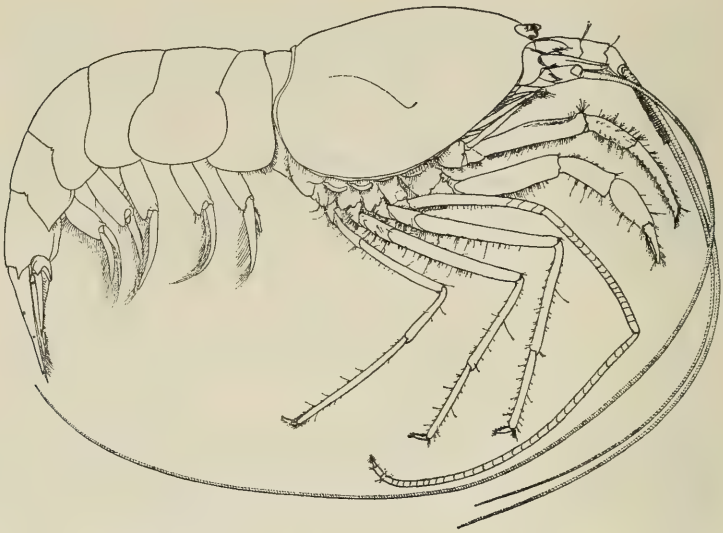


FIG. 5. *Calliasmata rimolii*, holotype ♀. × 2.8.

ment variably situated elsewhere beneath both dorsal and ventral surfaces of eyestalk.

Antennular peduncle (Figs. 6*a*, *c*) with 1st segment subequal in length to combined lengths of 2 distal segments. Stylocerite suboval or subtriangular in lateral view, distal end blunt, with or without minute denticle, falling far short of distal margin of first segment. Second segment longer than 3rd. Dorsolateral flagellum nearly 3 times as long as carapace, setiferous (fused) portion consisting of 19–21 articles, free part of shorter branch reduced to single short article (Fig. 6*h*). Ventromesial flagellum slightly shorter than dorsolateral.

Antennal scale (Fig. 6*c*) about twice as long as wide, barely overreaching 2nd segment of antennular peduncle, lateral margin nearly straight, terminating in strong distal tooth reaching nearly as far as distal margin of blade. Antennal peduncle reaching little beyond midlength of scale, basal segment with stout lateral tooth below base of scale and bluntly triangular lobe dorsally that appears toothlike in lateral view. Flagellum at least 4¾ times as long as carapace, about ⅔ again as long as entire animal.

Mandibles (Fig. 6*i*) without palp or incisor process; opposable surface of molar process dissimilar on right and left mandibles. First maxilla (Fig. 6*j*) with palp bilobed. Second maxilla (Fig. 6*k*) with proximal endite much reduced, distal endite rather deeply divided into broadly rounded distal portion and bluntly triangular proximal lobe. All maxillipeds with well-developed exopods. First maxilliped (Fig. 6*l*) with two

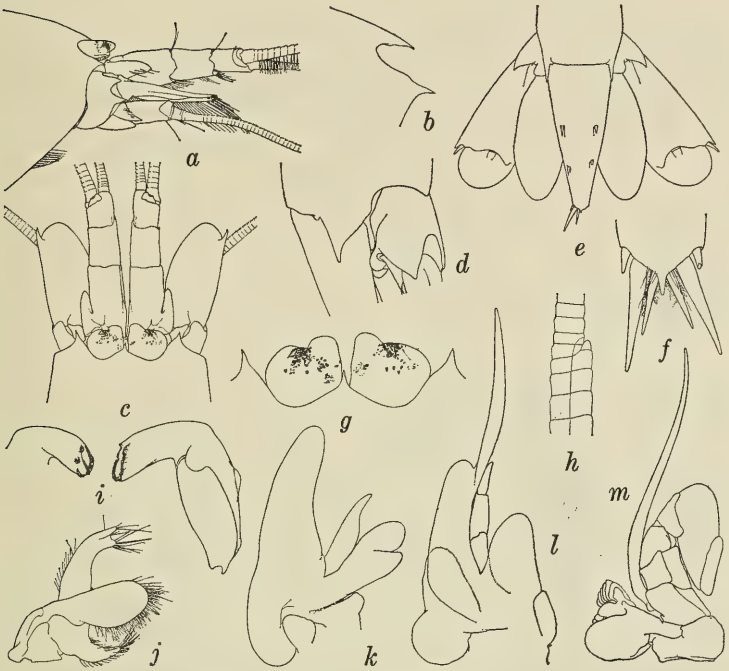



FIG. 6. *Calliasmata rimolii*, holotype ♀ (except *f*). *a*, Anterior region in lateral aspect; *b*, Rostrum and orbit in lateral aspect; *c*, Anterior region in dorsal aspect; *d*, Base of telson and uropod; *e*, Telson and uropods; *f*, Posterior end of telson of paratype ♀, carapace length 10.8 mm; *g*, Eyes in dorsal aspect; *h*, Distal end of setiferous portion of dorsolateral flagellum; *i*, Left and right mandibles in dorsal (oral) aspect; *j*, Right first maxilla; *k*, Right second maxilla; *l*, Right first maxilliped; *m*, Right second maxilliped. (*a*, *c*, *e*, × 4; *b*, *d*, *g*, *i–m*, × 8; *f*, *h*, × 17.)

endites separated by shallow notch, palp well-developed and 3-segmented, exopod with lash and narrow caridean lobe, epipod prominent. Second maxilliped (Fig. 6*m*) with terminal segment attached lengthwise to penultimate; exopod, epipod, and podobranch well-developed. Third maxilliped (Fig. 7*a*) overreaching antennal scale by length of distal and nearly ½ of penultimate segment, distal segment considerably less than twice as long as penultimate, terminating in 2 small curved spines and armed with about 6 movable spines on distal half or less of extensor margin; exopod reaching beyond midlength of antepenultimate segment; epipod and arthrobranch present.

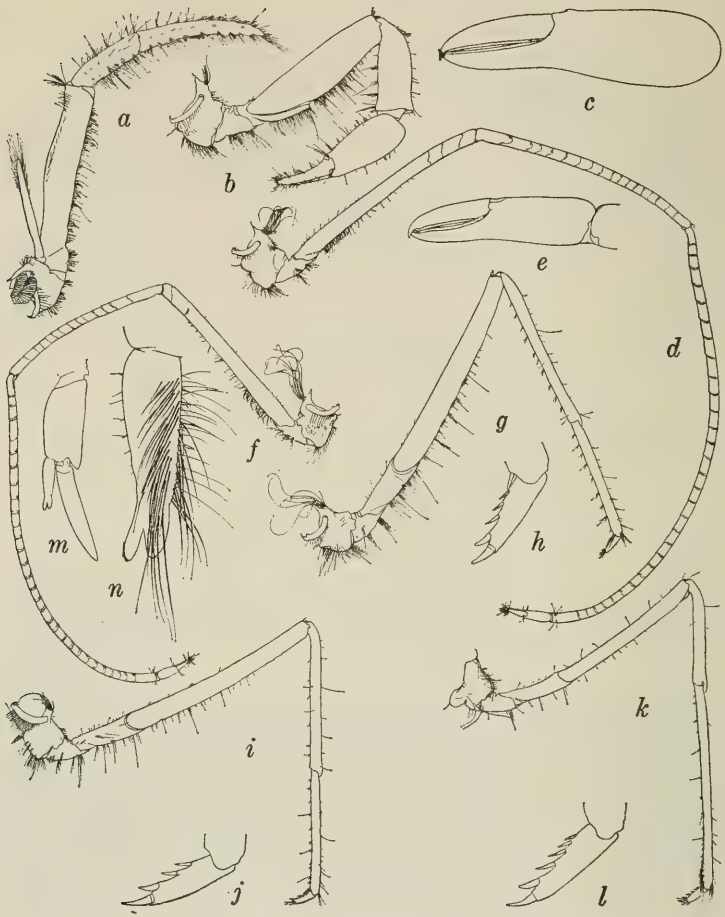



Fig. 7. *Calliasmata rimolii*, holotype ♀. *a*, Right third maxilliped; *b*, Right first pereopod; *c*, Same, chela; *d*, Right second pereopod; *e*, Same, chela; *f*, Left second pereopod; *g*, Right third pereopod; *h*, Same, dactyl; *i*, Right fourth pereopod; *j*, Same, dactyl; *k*, Right fifth pereopod; *l*, Same, dactyl; *m*, Right first pleopod; *n*, Same, endopod. (*a*, *b*, *d*, *f*, *g*, *i*, *k*, *m*, × 4; *c*, × 8; *e*, *h*, *j*, *l*, *n*, × 17.)

First pereopod (Fig. 7*b*) overreaching antennal scale by more than length of chela; chela (Fig. 7*c*) with fingers fully ⅔ as long as palm, dactyl terminating in 2 unequal, dark-colored spines embracing single dark tip of fixed finger; carpus about ⅔ as long as chela; merus distinctly

longer than chela; coxa bearing both straplike epipod and tuft of long filaments. Second pereopods (Figs. 7*d–f*) similar but unequal, right slightly to considerably longer than left; right overreaching antennal scale by combined lengths of chela, carpus, and ⅓ to ½ of merus, left by combined lengths of chela and 9/10 of carpus to combined lengths of chela carpus, and ¼ of merus. Carpus subdivided into 29 to 32 articles, merus into 12 to 19, and ischium into 3 to 5; ischium bearing series of stout curved setae along proximal half of flexor margin; coxa bearing both straplike epipod and tuft of long filaments. Third pereopod (Fig. 7*g*) overreaching antennal scale by combined lengths of dactyl, propodus, and about ½ of carpus; dactyl (Fig. 7*h*) armed with 3 or 4 movable spines on flexor margin, in addition to terminal spine; propodus more than 4 times as long as dactyl, bearing about 11 spinules distributed over entire length of flexor margin; carpus about 1½ times as long as propodus, bearing about 10 spinules on flexor margin; merus about 1⅘ times as long as carpus, bearing 3 appressed curved spines near and proximal to midlength; ischium no more than ⅓ as long as merus, bearing single submarginal spine in distal half of flexor margin; coxa with both straplike epipod and tuft of long filaments. Fourth pereopod (Fig. 7*i*) overreaching antennal scale by combined lengths of dactyl, propodus, and about ⅓ of merus; dactyl (Fig. 7*j*) armed with 3 or 4 movable spines on flexor margin, in addition to terminal spine; propodus about 4 times as long as dactyl, bearing about 12 spinules on flexor margin; carpus nearly 1⅓ times as long as propodus, bearing 6 or more spinules on flexor margin; merus more than 1¼ times as long as propodus, bearing single appressed spine near proximal end of flexor margin; ischium less than ⅓ as long as merus, bearing single submarginal spine near midlength of flexor margin; coxa with both straplike epipod and tuft of long filaments. Fifth pereopod (Fig. 7*k*) overreaching antennal scale by length of dactyl and about ½ of propodus; dactyl (Fig. 7*l*) armed with 5 movable spines on flexor margin, in addition to terminal spine; propodus about 6 times as long as dactyl, bearing nearly 20 spinules on flexor margin, those near distal end closer together and partially concealed by tufts of long setae; carpus slightly more than ½ as long as propodus, unarmed; merus nearly twice as long as carpus, unarmed; ischium about ⅖ as long as merus, unarmed; coxa with tuft of long filaments but no straplike epipod.

Endopod of 1st pleopod of female (Figs. 7*m, n*) divided into 2 lobes distally, mesial lobe bearing retinacular hooks. Uropods (Fig. 6*e*) usually slightly overreaching telson; lateral branch with prominent movable spine mesial to strong tooth at distal end of lateral margin and with nearly complete diaeresis.

*Color*: Pale red in life.

*Size*: Carapace length of female holotype, 11.1 mm; of female paratypes, 10.0 to 12.0 mm.

*Type-locality*: Cave 4 km from town of Estero Hondo (19°51'N, 71°11'W), Provincia de Puerto Plata, northern Dominican Republic.

*Material*: Five females (holotype, USNM 151205) collected at the type-locality, April 20, 1973, by Renato O. Rímoli.

*Habitat*: The cave in which *C. rimolii* was found is situated in a Pleistocene escarpment about one kilometer long and about 500 meters from the sea. The cave, the entrance to which was shaded by dense vegetation, was completely full of water, forming an underground pool with a maximum depth of two meters. Light penetrated to the bottom of the pool and there was little organic sediment. The water was clear and barely brackish with a temperature of 25°C, compared with an outside air temperature of 26°C at the time of collection. *Calliasmata rimolii* was numerous and was the only animal found in the cave.

Probably this cave qualifies as an anchialine habitat, as defined by Holthuis (1973:3), even though the water in the lake was "barely brackish" and no tidal influence was apparent.

*Name*: The species is named for the collector, Renato O. Rímoli.

*Remarks*: This species is very similar in general appearance to the previously unique type-species, *C. pholidota* Holthuis, 1973, from comparable habitats in the Sinai Peninsula, Ellice Islands, and Hawaiian Islands. Comparison of the five females from the Dominican Republic with part of the original series of *C. pholidota* (one female from the Sinai Peninsula and one male, two females from the Ellice Islands) deposited in the Smithsonian Institution reveals, however, that *C. rimolii* differs from the Indo-Pacific species in several characters, some of which might be considered to be of supraspecific importance. The integument of *C. rimolii* is much less firm and seems to be devoid of the scales and corresponding pits that are characteristic of *C. pholidota*. The carapace is more strongly inflated and the rostrum is consequently directed anteroventrad so that it is largely concealed by the eyes from lateral view; in dorsal view, the rostrum is more slender subapically, but there is considerable variation in this regard. Perhaps the most obvious differences between the two species are the rounded, rather than rectangular posteroventral margin of the first abdominal pleuron, the absence of a ventral spine on each of the third, fourth, and fifth abdominal pleura, and the acute, rather than rounded, posteroventral angle of the fifth pleuron in *C. rimolii*. The eyes are variable in shape in both species, but the anteromesial angle is usually more strongly produced into a subtruncate projection in *C. rimolii*. The stylocerite tends to be less produced anteriorly and to be blunter apically in *C. rimolii*, but it, too, is variable in both species. A final striking difference lies in the form of the endopod of the first pleopod of the female; in *C. pholidota*, it tapers to a simple blunt tip with terminal retinacular hooks, whereas in *C. rimolii* it is split distally into two divergent lobes, only the mesial one of which bears retinacular hooks.

Three other differences suggested by comparing the descriptions of the two species may not be significant. The dorsal lobe of the basal segment of the antennal peduncle is blunt or rounded in dorsal aspect in the specimens of *C. pholidota* examined, little more acute than it is in

*C. rimolii*; in lateral aspect, this lobe appears toothlike in both species. The third maxilliped may be a little longer and the spines on the distal segment less numerous in *C. rimolii*, but there is probably sufficient variation to minimize the importance of these differences when longer series of both species are compared. Only two of the available specimens of *C. pholidota* have both second pereopods; in each specimen, the right member of the pair is slightly or distinctly longer than the left, as in *C. rimolii*, but this character may prove to be of little importance in both species when additional material is examined.

Two of the characters mentioned above—the integumental scales and the spines on the abdominal pleura—were considered by Holthuis (1973:37) to be of generic significance, and a third—the form of the endopod of the first pleopod—might have been so treated if *C. rimolii* had been discovered first. Even the relatively few specimens thus far known of each species, however, suggests a variability that may be reflected in genetic instability at the generic level; there would therefore seem to be little justification for treating these two species as other than congeneric at the present time.

## Literature Cited

Chace, Fenner A., Jr. 1943. Two new blind prawns from Cuba with a synopsis of the subterranean Caridea of America. Proc. New England Zool. Club 22:25–40, 3 pls.

———. 1954. Two new subterranean shrimps (Decapoda: Caridea) from Florida and the West Indies, with a revised key to the American species. Journ. Washington Acad. Sci. 44(10):318–324, 2 figs.

———, and Horton H. Hobbs, Jr. 1969. The freshwater and terrestrial decapod crustaceans of the West Indies with special reference to Dominica. U.S. Nat. Mus. Bull. 292:i–vi, 1–258 pp., 76 figs., 5 pls.

———, and Lipke B. Holthuis. 1948. Land and fresh water decapod Crustacea from the Leeward Group and northern South America. *In* Hummelinck, Studies on the fauna of Curaçao, Aruba, Bonaire and the Venezuelan islands 3:21–28.

Holthuis, Lipke B. 1952. The subfamily Palaemoninae. Part II *in* A general revision of the Palaemonidae (Crustacea Decapoda Natantia) of the Americas. Allan Hancock Found. Occ. Pap. 12:396 pp., 55 pls.

———. 1973. Caridean shrimps found in land-locked saltwater pools at four Indo-West Pacific localities (Sinai Peninsula, Funafuti Atoll, Maui and Hawaii Islands), with the description of one new genus and four new species. Zool. Verh. Leiden 128:1–48, 13 figs., 7 pls.

Rathbun, Mary J. 1919. Stalk-eyed crustaceans of the Dutch West Indies. *In* Boeke, Rapport betreffende een voorloopig onderzoek

naar den toestand van de Visscherij en de Industrie van Zeeproducten in de Kolonie Curaçao ingevolge het Ministerieel Besluit van 22 November 1904 2:317–348, 5 figs.

DE SAUSSURE, H. 1857. Diagnoses de quelques crustacés nouveaux de l'Amérique tropicale. Rev. Mag. Zool. (2)9:501–505.

SCHMITT, WALDO L. 1936. Macruran and anomuran Crustacea from Bonaire, Curaçao and Aruba. No. 16 *in* Zoologische Ergebnisse einer Reise nach Bonaire, Curaçao und Aruba im Jahre 1930. Zool. Jahrb., Syst. 67:363–378, 3 pls.

VANDEL, A. 1964. Biospéologie. La biologie des animaux cavernicoles. Paris xviii + 619 pp.

———. 1965. Biospeleology. The biology of cavernicolous animals. New York (Pergamon Press) xxiv + 524 pp., 80 figs.

3

QH
1
B4X
NH

No. 5, pp. 45–50 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

APR 21 1975

# OBSERVATIONS ON *LEPUS CALLOTIS* IN NEW MEXICO

By Michael A. Bogan and Clyde Jones
*National Fish and Wildlife Laboratory, National Museum of Natural History, Washington, D.C. 20560*

The occurrence of *Lepus callotis gaillardi* Mearns in the United States has been unclear since the original description (Mearns 1896:560). During the resurvey of the Mexican-United States boundary in 1892 and 1893, E. A. Mearns and F. X. Holzner obtained six of these unique jack rabbits. The skin labels on three specimens taken 16 and 29 June 1892, state the animals were taken on the "Mexican Boundary Line, near White Water, Chihuahua." Two others, including the type of *L. gaillardi*, taken on 17 June 1892, read "near White Water, Chihuahua, on the Mex. Bound. Line." The skull tags of these five specimens read variously: "Plyas (sic) Valley, near White Water, Chihuahua, Mex.; West fork of Plyas (sic) Valley, near White Water, Chihuahua, Mexico; Mex. Bound. Line; Plyas (sic) Valley near White Water, Chihuahua." The holotype (USNM 20525/35714, skin and skull) also possesses red type labels, presumably added at the time of description, stating: "Playas Valley, near Mon. No. 63, Mex. Bound. Line." The original description (Mearns 1896:562) gives the type-locality as: "west fork of the Playas Valley near monument No. 63, Mexican boundary line." The remaining specimen, taken 15 September 1893, came from "Plyas (sic) Valley, Mex. Bd. Line" according to the skin tag, or "East Fork of Plyas (sic) Valley" according to the skull label. The skin tag of this specimen also bears the notation "Topotype."

All six of the above specimens were taken while the Boundary Commission was encamped at White Water, 1 mi S Monument No. 61. During the first visit there (13–29 June

1892) Mearns explored the east and west Playas Valleys (Mearns 1907:11), traveled south to San Francisco Canyon (5 mi SW Monument No. 63), and explored the San Luis Mountains in this area (Mearns 1907:12). Mearns' original "Field Catalog" (files of USNM) for this first visit gives "Whitewater, Chihuahua, Mexico" as the locality for specimens taken 16–17 June 1892, and "Mexican boundary line, near Whitewater" as the locality for the 29 June 1892 specimen. We can find no original Field Catalog listing the specimen taken in September 1893.

During his travels with the Boundary Commission, Mearns was in the company of competent surveyors. The main missions of the party were to resurvey the border and erect new monuments. It thus seems likely that he would have been cognizant of the actual provenance of these specimens. Had the animals been taken in New Mexico, we presume he would have labeled them as from Grant County (now Hidalgo County), New Mexico, as he did with other specimens taken before and after his stay at Whitewater. Although no definite answer as to the exact locality of these animals can be given now, our conclusion is that all the animals came from the Mexican side of the boundary.

The plethora of localities for these jack rabbits has resulted in considerable confusion by later workers. Lyon and Osgood (1909:28), apparently relying on the type description (Mearns 1896:562), gave the type-locality as "West fork of the Playas Valley, near Monument No. 63, Mexican boundary line." Bailey (1932:53) ascribed the holotype to the "Mexican boundline, near Monument 63, west arm of Playas Valley, southwestern New Mexico." Furthermore, he stated (Bailey 1932) that "besides the type-specimen that he (Mearns) collected, he secured a series of five from White Water just below the international boundary line."

Bailey (1932) also reported, on the basis of field work in New Mexico, that "ranchmen in 1908 reported white-sided jack rabbits, which they called antelope rabbits" in the southern end of both the Playas and Animas Valleys. E. A. Goldman (files of Biological Survey 1908) also reported having seen

this species in these areas, although no specimens were known from the Animas Valley.

Poole and Schantz (1942:211), in their catalog of type-specimens, added to the confusion by giving the type-locality for *L. gaillardi* as: "West fork of the Playas Valley, near Monument No. 63, Mexican boundary line, Grant County, N. Mex." Hall (1951:188) listed all localities known to him for *L. gaillardi*, including Poole and Schantz's Grant County "record" and Bailey's reported sight records for the Animas Valley. The map drawn from these localities artifically extended the range of this species far into New Mexico because present day Grant County is well to the north of the Mexican boundary; the County having since been divided to form Luna and Hidalgo Counties. Hall and Kelson (1959:286) gave the type-locality as in Hidalgo County, although their map (p. 288) does not reflect this change.

Anderson and Gaunt (1962) and Anderson (1972) did much to correct the confusion regarding Mearns' localities, and Anderson and Gaunt (1962:8) also recorded two specimens taken in the "south end of west side of Playas Valley, 4600 feet" on 6 September 1931, and housed in the Museum of Vertebrate Zoology, University of California, Berkeley. These two specimens appear to be the only unquestioned records from New Mexico, and are reported as such by Findley et al. (1975). Anderson and Gaunt (1962), however, allocate the type and the 1893 specimen to New Mexico, an allocation that seems erroneous to us.

Regardless of the actual provenance of these early specimens, *L. callotis gaillardi* must be regarded as an extremely rare mammal in this area of New Mexico and Chihuahua, and the recent acquisition of a specimen seems noteworthy in this respect. We obtained an adult female *L. callotis* about 0.5 km N Cloverdale, Hidalgo County, New Mexico (labeled "Cloverdale"), on 19 July 1974. The animal, the first taken in 43 years in New Mexico, also substantiates the 1908 reports of this species in the Animas Valley.

Our specimen (USNM 506267) was lactating and also contained two embryos measuring 9 mm (crown-rump). Of the

five females taken by Mearns and Holzner, one was noted to contain "three small fetuses."

Anderson (1972) has noted the tendency for these hares to occur in pairs, an observation also made by E. A. Goldman and V. Bailey (reports in files of Biological Survey). Our own observations confirm this, and during our field work around Cloverdale on 18 and 19 July 1974, we saw at least two and perhaps as many as four pairs. On 20 July we returned to this area and made an intensive search for *L. callotis*, but found none.

The jack rabbits, resting within 5 m of one another, flushed in front of us at distances from 5 to 25 m and ran swiftly together for distances up to 0.5 km. Their nests, which concealed them perfectly, consisted of bare oval patches (approximately 30 cm long) in clumps of tabosa grass (*Hilaria mutica*). All jack rabbits seen by us were flushed within stands of this grass, which occurred in large patches in this part of the Animas Valley. Once seen (as a jack rabbit vacated it), the nests were easy to spot; one such nest contained a partially chewed flower of *Cirsium* sp. The stomach of our specimen contained finely-chewed green plant material.

Our own observations agree closely with those made by Vernon Bailey in Chihuahua in 1932 and contained in unpublished files of the Biological Survey:

"My greatest thrill of the trip was the first view of this wonderful rabbit in life, and my first specimen collected. Riding across a high grassy mesa, about 10 miles southwest of Ramos, at 5,500 feet in (the) Upper Sonoran Zone on October 30, two of these rabbits jumped out of the brown grass just in front of my horse, and after running a few rods, squatted in the grass which matched their color exactly. The curly buffy brown hair of the backs was all that could be seen except the eyes of the nearest one which I quickly auxed from the saddle. The other, a little farther off, I tried to stalk on foot but did not get near enough for the shotgun and missed it with the rifle as it sped over the smooth prairie with white sides glistening and great ears erect, as striking a mark as an antelope, and almost as swift.

"They are said to be common on these high prairie mesas

and always two together. The local name is *Snow Sides.* The specimen was an adult male, perfectly healthy and as fat as a rabbit ever gets. Well stewed it was delicious meat and made two meals for four of us. Its stomach contained tender grasses and other prairie plants of this high prairie flora."

ACKNOWLEDGEMENTS

We thank B. Harvey and P. Mehlhop for assistance in the field. Henry Setzer and Don Wilson read the manuscript.

LITERATURE CITED

ANDERSON, S. 1972. Mammals of Chihuahua, taxonomy and distribution. Bull. Amer. Mus. Nat. Hist. 148:149–410.

———, AND A. S. GAUNT. 1962. A classification of the white-sided jack rabbits of Mexico. Amer. Mus. Novitates 2088:1–16.

BAILEY, V. 1932. Mammals of New Mexico. North Amer. Fauna, No. 53:1–412.

FINDLEY, J. S., A. H. HARRIS, D. E. WILSON AND C. JONES. 1975. The Mammals of New Mexico. Univ. New Mex. Press. In press.

HALL, E. R. 1951. A synopsis of the North American Lagomorpha. Univ. Kans. Publ., Mus. Nat. Hist. 5:119–202.

———, AND K. R. KELSON. 1959. The Mammals of North America. Ronald Press, New York. Vol. 1. xxx + 546 + 79 pp.

LYON, M. W., JR. AND W. H. OSGOOD. 1909. Catalogue of the type-specimens of mammals in the United States National Museum, including the Biological Survey Collection. U.S. Nat. Mus. Bull. 62: x + 325 pp.

MEARNS, E. A. 1896. Preliminary description of a new subgenus and six new species and subspecies of hares, from the Mexican border of the United States. Proc. U.S. Nat. Mus. 17:551–565.

———. 1907. Mammals of the Mexican boundary of the United States. U.S. Nat. Mus. Bull. 56:xv + 530 pp.

POOLE, A. J. AND V. S. SCHANTZ. 1942. Catalog of the type specimens of mammals in the United States National Museum, including the Biological Surveys Collection. U.S. Nat. Mus. Bull. 178:xiii + 705 pp.

3

QH
1
B4X
NH

, pp. 51–58 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# A NEW SPECIES OF FRESHWATER SHRIMP (GENUS *ATYA*) FROM THE PACIFIC DRAINAGES OF PANAMÁ

By Lawrence G. Abele
*Department of Biological Science, Florida State University, Tallahassee, Florida 32306*

APR 23 1975

This new species of *Atya* was collected during a survey of the decapod crustacean fauna of Panamá (Abele, 1972) and is described here as a contribution towards a knowledge of that fauna.

The abbreviation *cl* refers to carapace length measured from the orbital margin to the posterior margin of the carapace; *tl* to total length measured from the apex of the rostrum to the distal margin of the telson; UPRC to the University of Panamá Reference Collection, Panamá City, Republic of Panamá; USNM to the National Museum of Natural History, Washington, D.C.

**Atya dressleri** new species
Figures 1–2

*Material*: Panamá, Pacific drainage, Veraguas Province, Río Santa Maria drainage, small stream N of Santa Fe, fast flowing, riffles present, 600 m elevation, 9 February 1962, H. L. Loftin, E. W. Tyson, 6 specimens, USNM.—Panamá, Pacific drainage, Veraguas Province, Río Santa María drainage, headwaters of Río San Juan about 15 km above Calobre, fast flowing, riffles present, 566 m elevation, 20 February 1973, L. G. Abele, M. H. Robinson, LGA 73-16, 1 male holotype, 2 female paratypes, USNM, 1 male paratype UPRC.—Panamá, Pacific drainage, Panamá Province, Río Pacora drainage, Río Cabra above Cerro Azul, fast flowing, riffles present, 650 m elevation, 1968, 2 males (molts of aquarium specimens), R. Dressler, USNM.

*Measurements*: Male holotype *cl* 20.2 mm, *tl* 52.4 mm; male paratype *cl* 9.5 mm, *tl* 31.4 mm; female paratypes *cl* 18.5, 20.2 mm, *tl* 59.4, 60.2 mm.

*Diagnosis*: Rostrum triangular in dorsal view, no lateral teeth; third pereiopod with small, depressed tubercles; podobranch present on second maxilliped.

*Description*: The rostrum (Fig. 1A) is acute, triangular in dorsal view, laterally compressed with a distinct dorsal carina. It just reaches to the distal margin of the basal antennular segment. The lateral margins lack lobes or extensions, being almost straight from the orbits to the apex. There are 1–2 small dorsal notches, which may be absent, just posterior to the apex and 1–2 distinct ventral teeth (Fig. 1B). The antennal spine arises at the lower margin of the orbit and a bluntly acute pterygostomial spine is present. There are no other spines on the carapace, which lacks pubescence.

The first three pleura are broadly rounded; the fourth is slightly angled and the fifth and sixth are distinctly angled but blunt (Fig. 2). There is a subtriangular lobe with a dorsal notch above the sixth pleuron. There are no spines on the ventral margins of any pleura in either sex. The fourth abdominal segment is about 1.25 times the length of the fifth, 1.1 times the sixth and 1.06 times the length of the telson. The sixth segment is about 1.15 times the length of the fifth segment and only slightly shorter than the telson. The length of the telson is slightly less than twice the width (Fig. 1E). It is armed dorsally with two rows of 10–12 spines (one row on each side of the midline). The rows begin about four-sevenths of the distance from the posterior margin with each row diverging distally and ending with 1 or 2 small spines at the lateral angles adjacent to a longer medial spine on the distal margin of the telson. There is a distinct depression between the rows of spines which terminates in a large spine just proximal to the distal margin of the telson. There are long, strong setae on the distal margin of the telson. The anal tubercle (Fig. 1D) is long and acute.

The eyes (Fig. 1B) are well-developed and pigmented.

The basal antennular segment (Fig. 1C) is armed with a well-developed stylocerite which does not extend to the distal margin. The distal margin is armed with 7–9 dark colored spines which decrease in size laterally. The second segment is about twice as long as wide and has a row of 7–10 small spines on the mid-dorsal surface. The distal margin is armed with 5–6 spines. The ultimate segment is armed with 5–8 small spines at the insertion of the lateral flagellum. The ultimate segment is about 0.56 times the length of the second; the second is slightly shorter than the total length of the basal segment but is about 1.77 times the visible portion of the basal segment.

The basicerite has a blunt lobe dorsally and a small lateral spine which does not extend to the tip of the stylocerite. The lamella of the scaphocerite extends beyond the antennular peduncle; a lateral tooth arises about two-thirds of the distance from the base. The carpocerite is shorter than the antennular peduncle and is armed with about 12 small spines at the distal margin. The antenna is slightly longer than the body.

The branchial formula is:

| | Maxillipeds | | | Pereiopods | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 |
| pleurobranch | – | – | – | 1 | 1 | 1 | 1 | 1 |
| arthrobranch | – | – | 2 | 1 | – | – | – | – |
| podobranch | – | 1 | – | – | – | – | – | – |
| epipod | 1 | 1 | 1 | 1 | 1 | 1 | 1 | – |
| exopod | 1 | 1 | 1 | – | – | – | – | – |

The third maxilliped extends to the distal end of the carpocerite or slightly beyond it; it does not extend to the distal end of the antennular peduncle. The exopod extends to the distal margin of the penultimate segment. The antepenultimate segment is about 1.3 times the length of the penultimate which is about 1.2 times the length of the ultimate segment. There are rows of setae on the penultimate and ultimate segments, the latter having large serrate, spoon-shaped setae distally.

The first two pereiopods are typical of the genus and similar. The third pereiopod (Fig. 1F) is unarmed and is only slightly longer than the fourth and fifth; the propodus extends beyond the antennular peduncle. There is a row of pubescence from the proximal lateral part of the merus to the distal part of the propodus. Depressed squamose tubercles are present on the lateral surfaces of the propodus, carpus and distal three-fourths of the merus. The merus is slightly more than 5 times as long as wide; it is about 3 times the length of the carpus, more than twice the length of the propodus and about 7 times the length of the dactylus. The dactylus (Fig. 1G) has a circular depression laterally with setae present; the ventral margin is armed with about 7 strong spines and the distal portion is narrow and acute. The tip of the dactylus of the fourth pereiopod extends to the distal margin of the antennular peduncle. The fourth pereiopod has many fewer tubercles than the third and is armed with 4 spines: 1 on the distal lateral surface and 2 long movable ones on the inner surface of the merus; the distal one is very long being about one-sixth the length of the merus; the fourth spine is on the proximal part of the carpus. The carpus is slightly less than half the length of the merus and shorter than the propodus. The dactylus is similar to that of the third pereiopod. The fifth pereiopod extends just to the basicerite; it is armed on the inner surface of the merus with 3 evenly spaced spines and 1 spine on the distal outer surface of the merus; the propodus is armed with rows of small dark-colored spines on the inner surface. The merus is longer than the carpus but both are shorter than the propodus. The dactylus is similar in form to the others. In terms of the relative lengths of segments the merus becomes shorter from the third to the fifth pereiopod while the propodus becomes longer.

The endopod of the first male pleopod (Fig. 1I) is subrectangular in

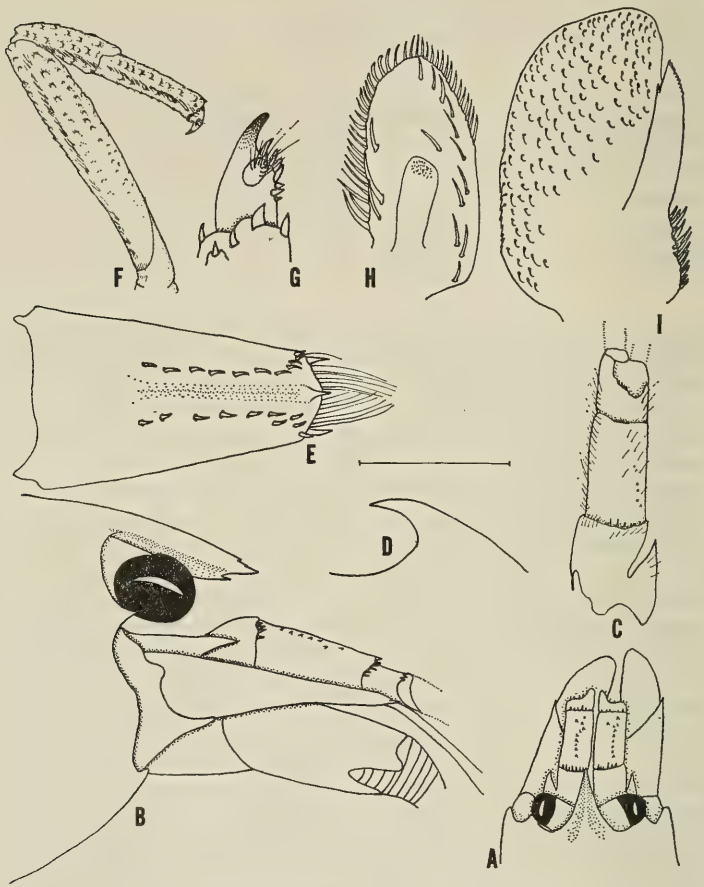



FIG. 1. *Atya dressleri* new species. A, Dorsal view of anterior region of carapace. B, Lateral view of anterior portion of carapace. C, Antennal peduncle. D, Preanal carina. E, Telson. F, Third pereiopod. G, Dactylus of F. H, Appendix masculina of male. I, Endopod of first male pleopod. D, H, I, Holotype male, others paratype female. Scale = 15 mm for A, F; 7 mm for B, C, E; 4 mm for D, G, H, I.

shape, it is covered on one side with very small backwardly directed spines; the other side is unarmed. It is about subequal in length to the exopod. The appendix masculina (Fig. 1H) is slightly more than twice as long as wide; it has strong curved setae present on the margins and a few scattered setae anterior to the appendix interna. The uropods

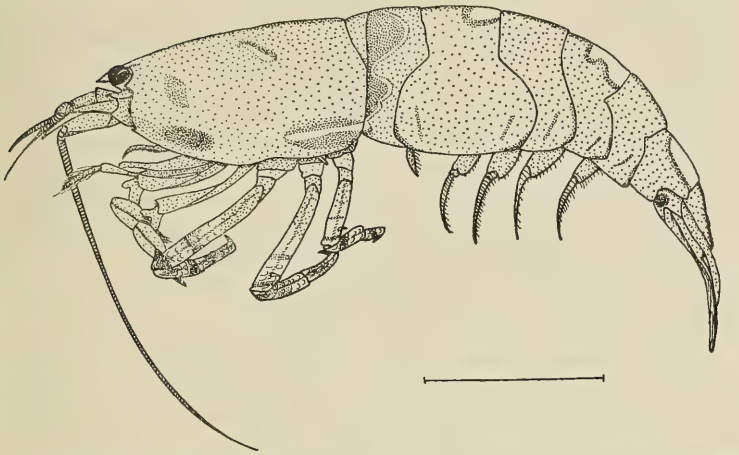


FIG. 2. *Atya dressleri* new species. Lateral view of male showing one of the more common color patterns. Scale = 15 mm.

both extend well beyond the telson; the diaeresis of the exopod is armed with about 18 to 21 spinules.

*Color*: The color pattern of a live male is shown in Figure 2. The ground color is light brown with both yellow and black specks present. The carapace is light brown with a dark brown oblong area on the anterior lateral surface just above an elongated black spot. Posterior to and above these is a short yellow rectangular area with a black posterior border. On the lower posterior part of the carapace is a long yellow stripe distinctly bordered by black. The first abdominal segment has a sinuous black area covering the anterior part of the segment; the black is bordered by a distinct narrow yellow band. The second abdominal segment has the anterior and posterior pleural angles bordered in black with an oblique black stripe medial to each. There is a distinct yellow area bordered by a black band on the dorsal posterior part of the segment. The third segment has the pleural angle black with an oblique stripe anterior to it. There is an hourglass shaped yellow area bordered in black on the posterior dorsal surface of the fourth segment; the pleural angle is black with an oblique black stripe anterior to it. The pleural angle of the fifth segment is black with an oblique black stripe anterior to it. The sixth segment has almost the entire dorsal surface yellow with a black border. There is a distinct black spot at the base of the uropods.

The antennular peduncle has yellow markings on the dorsal surface of the antepenultimate and penultimate segments. The flagella are brown.

The third through the fifth pereiopods have 7 yellow bands: 1 at the coxa-ischium, 1 about the middle and 1 towards the end of the merus, 1 at the merus carpus joint, 1 distally on the carpus and 1 each at the proximal and distal ends of the propodus.

The remainder of the shrimp is an even brown color.

The color pattern varied among individuals with some individuals being an even brown, others having the dorsal markings fused into a dorsal stripe and others having variations on the color pattern described. There was no obvious sexual dimorphism although small specimens were usually an even light brown without any pattern.

*Etymology*: This species is named for Robert L. Dressler who introduced me to the natural history of Panamá.

*Type locality*: Panamá, Veraguas Province, approximately 15 km above the town of Calobre, 566 meters elevation, Pacific drainage, Río San Juan emptying out of Laguna Yeguada eventually entering the Río Santa María drainage system. The stream was from 0.2 to 4 m wide with the depth to 1 m; riffles were present in narrow sections and there was overhanging vegetation.

*Habitat*: *Atya dressleri* occurs in small fast running freshwater streams from about 560 to 650 m elevation. All of the specimens were collected from vegetation or overhanging roots in areas where the current was swift.

*Distribution*: The species has been taken at three localities in Panamá; the type locality, above Santa Fe in the same drainage and on Cerro Jefe in the Pacora drainage, Panamá Province.

*Remarks*: *Atya dressleri* is most closely related to *A. lanipes* Holthuis, 1963 which occurs on St. Thomas, Virgin Islands and on Puerto Rico. The two species can be immediately distinguished in that *A. dressleri* has squamose tubercles on the third pereiopods while *A. lanipes* lacks tubercles. Other features which appear to separate the two species are the following: the merus and carpus of the third pereiopod are unarmed in *A. dressleri* while the merus is armed with 3 and the carpus with 1 spine in *A. lanipes*; the telson is less than twice as long as wide in *A. dressleri* while it is more than twice as long as wide in *A. lanipes*; the dorsal surface of the telson is armed with 10–12 spines in *A. dressleri* while it is armed with 6–7 spines in *A. lanipes*; a podobranch is present on the second maxilliped in *A. dressleri* while it is lacking in *A. lanipes*.

*Atya dressleri* can be distinguished from all other American species of *Atya* in that the carapace is unarmed in the hepatic and postorbital regions and the rostrum lacks lateral lobes.

The species is fairly long lived. Robert Dressler has kept adult individuals alive in an aquarium for more than 5 years.

*Discussion*: Six species of the genus *Atya* occur in Panamá. *Atya scabra* (Leach, 1815) and *A. innocous* (Herbst, 1792) occur in Atlantic drainage streams while *A. dressleri* new species, *A. tenella* Smith (1871), *A. rivalis* Smith (1871) and *A. crassa* Smith (1871) occur in Pacific drainage streams. Doflein (1900) reported *A. crassa* from the Atlantic

coast of Panamá but this seems to be the only record. No other locality data were given so it was not possible to recollect the area. *Atya crassa* was collected in the Pacific drainage of Río Bayano and from no other areas in Panamá, and *A. dressleri* is known from only a few localities, but all other species are widely distributed in Panamá. Some question has been raised concerning the specific distinction of the Pacific *A. tenella* from the Atlantic *A. innocous* and of the Pacific *A. rivalis* from the Atlantic *A. scabra* (see Bouvier, 1925; Chace and Hobbs, 1969). Holthuis (1966) considered *A. scabra* and *A. rivalis* to be distinct and pointed out some differences between them. While a review of the genus is not the objective of the present report, it seems worthwhile to point out that *A. tenella* and *A. rivalis* appear to be valid species. In addition, a comparison of the figures and description of *A. ortmannoides* Villalobas (1956) with *A. tenella* reveals that they are very similar. A detailed comparison between these species is necessary to resolve their status.

In *A. innocous* the ventral borders of the third through the fifth pleura are armed with short strong denticles (Chace and Hobbs, 1969:65, fig. 10c), while in *A. tenella* they are unarmed. In *A. scabra* the ventral borders of the second through the fifth pleura are armed with short strong denticles (Chace and Hobbs, 1969:65, fig. 10f), while in *A. rivalis* only the third through fifth pleura are armed; the second pleuron is unarmed. These differences were found to be constant on more than 25 specimens of each of the 4 species. There appeared to be other differences in the spination and form of the antennal peduncles, in the shape of the preanal carinae and in the robustness of the legs but these were not examined in detail.

## Literature Cited

Abele, L. G. 1972. Comparative habitat diversity and faunal relationships between the Pacific and Caribbean Panamanian decapod Crustacea: A preliminary report with some remarks on the crustacean fauna of Panamá. pp. 125–138. *In* M. L. Jones (ed.). The Panamic biota: some observations prior to a sea level canal. Bull. Biol. Soc. Washington, No. 2, 1972.

Bouvier, E. L. 1925. Recherches sur la morphologie, les variations, la distribution geographique des Crevettes de la famille des Atyides. Encyl. Entom. Ser A, 4:1–370, figs. 1–716.

Chace, F. A., Jr. and H. H. Hobbs, Jr. 1969. The freshwater and terrestrial decapod crustaceans of the West Indies with special reference to Dominica. Bull. U.S. Nat. Mus. 292:v, 1–258, figs. 1–76.

Doflein, F. 1900. Weitere Mitteilungen über dekapode Crustaceen der k. bayerischen Staatssammlungen. Sitzung. Math.-Phys. Classe Kgl. Bayer. Akad. Wissen. Munchen 1900, I:125–145.

Herbst, J. F. W. 1791–1796. Versuch einer Naturgeschichte der

Krabben und Krebse nebst einer systematischen Beschreibung ihrer verschiedenen Arten, 2:i–viii, 1–226, pls. 22–46.

Holthuis, L. B. 1963. Two new species of fresh-water shrimp (Crustacea Decapoda) from the West Indies. Proc. Kon. Nederlandsche Akad. Wetensch. 66:61–69, 3 figs.

———. 1966. The freshwater shrimps of the Island of Annobon, West Africa. *In* The R/V *Pillsbury* deep-sea biological expedition to the Gulf of Guinea, 1964–65. II. Stud. Trop. Oceanogr., No. 4(1):224–239, figs. 1–5.

Leach, W. E. 1815. A tabular view of the external characters of four classes of animals which Linné arranged under Insecta; with the distribution of the genera composing three of these classes into orders, etc. and descriptions of several new genera and species. Trans. Linn. Soc. London 11:306–400.

Smith, S. I. 1871. List of the Crustacea collected by J. A. McNiel in Central America. Rep. Peabody Acad. Sci. 1869:87–98.

Villalobos, A. F. 1956. Contribucion al conocimiento de las *Atyidae* de Mexico I. Una nueva especie de *Atya* de la vertiente del Pacifico del estado de Michoacán. An. Inst. Biol., Univ. México 26(2[for 1955]):459–475, figs. 1–6.

QH
1
B4X
NH

7, pp. 59–72 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# *ASELLUS* (*ASELLUS*) *ALASKENSIS*, N. SP., THE FIRST ALASKAN *ASELLUS*, WITH REMARKS ON ITS ASIAN AFFINITIES (CRUSTACEA: ISOPODA: ASELLIDAE)

By Thomas E. Bowman and Charlotte Holmquist
*Department of Invertebrate Zoology*
*Smithsonian Institution, Washington, D.C. 20560, and*
*Sektionen för Evertebratzoologi*
*Naturhistoriska Riksmuseet, S-10405 Stockholm*

North American freshwater isopods of the family Asellidae are widespread east of the Great Plains in the United States and southern Canada (to about 46°N). West of the Great Plains asellids apparently do not occur naturally until they reappear in the Pacific Coast states and the province of British Columbia (Williams, 1970; Bowman, 1974). *Asellus communis* Say, a species that is distributed mainly in the northeastern United States and southern Canada, occurs in Boulder and Larimer counties, Colorado, but was probably introduced there by man (Williams, 1970). Winger, Peters, Donahoo, Barnes, and White (1972) reported *Asellus tomalensis* Harford from the Provo River, Utah. Dr. Winger kindly sent some of the Utah specimens, and they proved to be *A. racovitzai racovitzai* Williams, a form with a distribution similar to that of *A. communis*. It appears likely that the Provo River populations were also introduced.

Assuming artificial transference of the Colorado and Utah asellids, a wide geographic gap separates the eastern and west coast populations of *Asellus*. It has been suggested that the western species, *A. occidentalis* Williams and *A. tomalensis* Harford, are more closely related to Asian than to eastern North American asellids (Henry and Magniez, 1970), but this seems unlikely (Bowman, 1974).

The northernmost record for a west coast *Asellus* is Double Bay, Hansen Island, Queen Charlotte Strait (50°35′N, 126° 46′W) [Williams (1970) erroneously located Double Bay on Vancouver Island; the correct location is given in Bousfield's (1963) station list (Bousfield, in litt.)]. The 4 samples reported below of a new species from Alaska, from which asellids were previously unknown, extend the record slightly north of the Arctic Circle. The new species is noteworthy not only because it is the first known Alaskan asellid, but also because it belongs to *Asellus* (*Asellus*), restricted by Henry and Magniez (1970) to include only 5 Eurasian species and 8 troglobitic species from Japan. The Alaskan asellid thus has affinities with Eurasian rather than with North American species of *Asellus*, most of which have been assigned to *Conasellus* Stammer (1932) by Henry and Magniez. The resulting zoogeographical implications are discussed below.

**Asellus (Asellus) alaskensis** new species
Figures 1–10, 12–24, 27–32

[?] *Asellus* sp.—Watson, Davis, and Hanson, 1966, p. 576 [in list].

*Material examined*: All from the Noatak and Selawik lowlands, Alaska. Niglaktak Lake (66°35.5′N, 159°56′W), 22 August 1968, 1 ♂, 2 ♀; 19 September 1970, 59 ♂ ♀; collected by Charlotte Holmquist. Inland Lake (66°28′N, 159°50′W), 22 August 1968, 1 ♀, collected by Charlotte Holmquist. (For details of the 2 lakes see Holmquist, 1975). "Lake No. 1," Noatak River Drainage Basin, 14.5 km east of Kiligmak Inlet, collected by Donald G. Huggins: 15 August 1973, 43 ♂ ♀; 18 August 1973, open water on *Lemna*, 40 ♂ ♀

*Types*: Holotype, 7 mm ♂, from "Lake No. 1," August 1973, USNM 151224. The remaining specimens listed above are paratypes. The paratypes from Niglaktak Lake have been deposited in the Naturhistoriska Riksmuseet, Stockholm; those from "Lake No. 1" have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, except for 10 specimens from the 18 August collection which were returned to Dr. Huggins.

---

→

Figs. 1–10. *Asellus alaskensis*: 1, ♀, dorsal; 2, ♀ head and pereonite 1, dorsal; 3, ♀ antenna 1, dorsal; 4, ♀ antenna 2, ventral; 5, ♂ right mandible; 6, Incisor of ♂ right mandible; 7, Incisor and lacinia of ♂

left mandible; 8, ♂ mandibular palp; 9, ♀ right uropod, dorsal; 10, Protopod of ♀ left uropod, ventral. Fig. 11, *Asellus latifrons*, ♂ urosome (copied from Birstein, 1951).

*Diagnosis*: With the characters of the subgenus *Asellus* as defined by Henry and Magniez (1970) and closely resembling *A. latifrons* Birstein (1947), but distinguished by the absence of a rostrum, the shorter and blunter postmandibular lobes, the less prominent caudomedial lobe of the telson, the relatively shorter uropodal rami, and the narrower ♀ pleopod 2.

*Description*: Length of largest ♂ (excluding antennae and uropods) 7.4 mm. Other ♂♂ with differentiated pleopods 1 and 2, 5.3–6.2 mm. ♀♀ with small oostegites, 6.2 mm. Body gradually increasing in width to pereonite 7; greatest width about ⅖ length. Head about twice as wide as long; anterior margin shallowly concave; postmandibular lobes separated by deep fissure, latter broader and more rounded medially than in *A. latifrons*; head more rounded anterior to fissure and postmandibular lobes shorter and more obtuse than in *A. latifrons*.

Pereonites broadly expanded laterally; insertions of pereopods set well in from lateral margins of pereonites; coxae much reduced, not visible in dorsal view. Pereonite 7 overlapping anterolateral parts of pleotelson.

Telson about ⅓ wider than long; caudomedial lobe relatively broader and less sharply delimited than in *A. latifrons*. Margins of telson densely setose.

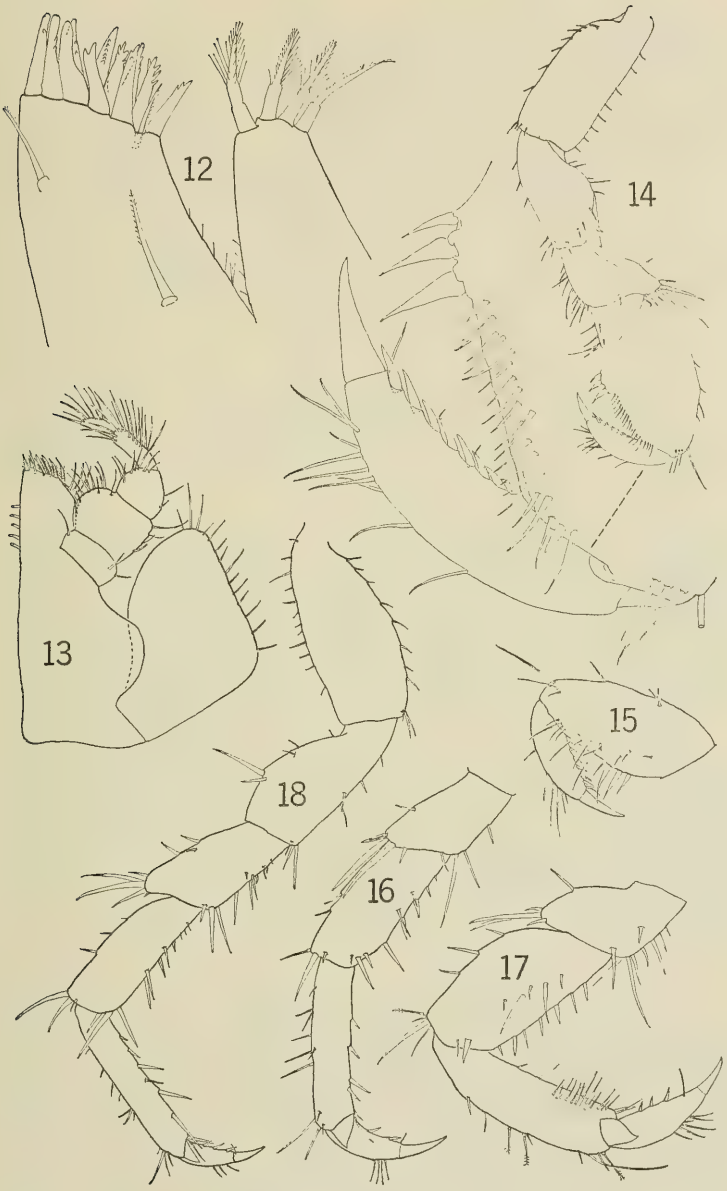
Antenna 1 reaching distal third of last segment of antenna 2 peduncle; flagellum of 6–7 segments, last 3 segments each bearing esthete. Antenna 2 about 0.6 length of body; last segment of peduncle about 1.5 times as long as preceding segment; flagellum of 25–35 segments.

Mandible with 4-cuspidate incisors and lacinia mobilis; spine row of right mandible with 9 dentate and plumose spines, of left mandible with 7 plumose spines; palp as in Fig. 8. Maxilla 1, apex of outer lobe with 11 dentate spines and 1 plumose seta, body of outer lobe with 2 additional plumose setae; inner lobe with 4 apical plumose setae. Maxilla 2, outer lobe with 12 and 10 setae on outer and inner lamina respectively; inner lobe with oblique row of 23 setae. Maxilliped with 4–5 retinaculae.

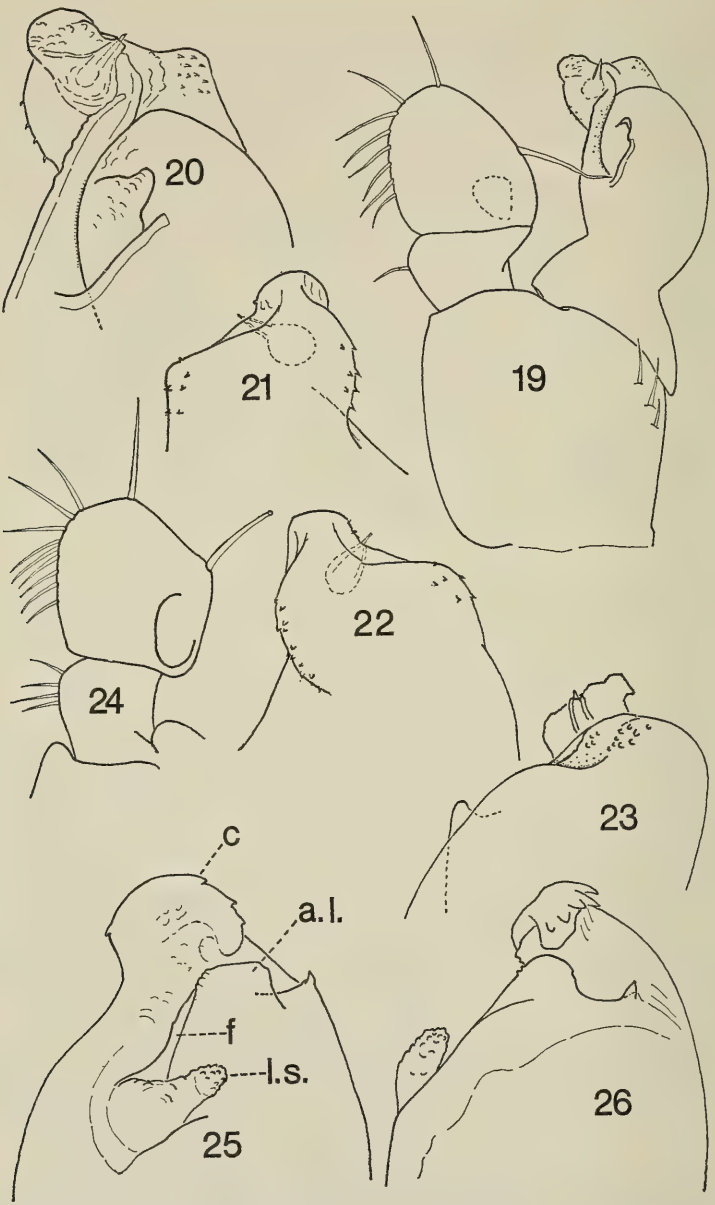
Pereopod 1, propus nearly twice as long as wide, palm defined by 3 spines borne on small boss in ♂, but flush with palm in ♀; dactyl with 7–8 spines on posterior margin. Dactyls of pereopods 3–7 with 2–5 spines, fewer on more posterior dactyls. Pereopod 4 more robust in ♂ than in ♀; merus and carpus broader and more spinose in ♂; propus of ♂ with cluster of slender spines distally.

Male pleopod 1 quadrate, slightly longer than pleopod 2; protopod half as long as exopod, with 3–4 retinaculae; exopod subrectangular, nearly twice as long as broad, lateral and distal margins armed with long plumose setae, those on distal margin longer, shorter naked setae inserted submarginally.

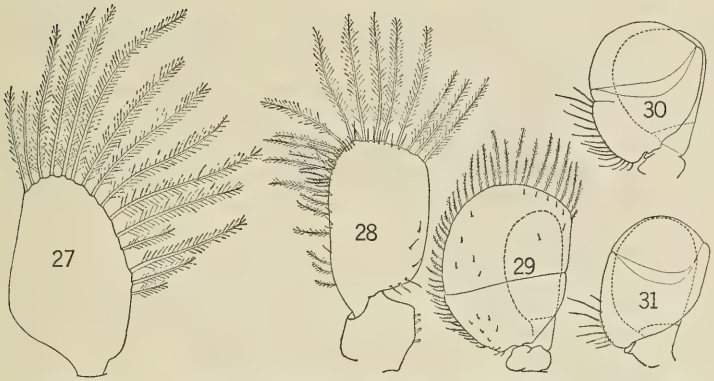
Male pleopod 2 protopod about as long as wide, with 3–5 distomedial setae. Exopod ⅝ as long as protopod; proximal segment with 1–4 setae on lateral margin; distal segment oval, with 8–10 lateral setae and 1–2 larger medial setae, proximomedial part of posterior surface with well developed catch lobe. Endopod (see discussion below for terms used)




FIGS. 12–18. *Asellus alaskensis*: 12, ♂ maxilla 1; 13, ♂ maxilliped; 14, ♂ right pereopod 1; 15, ♀ left pereopod 1; 16, ♀ pereopod 4; 17, ♂ pereopod 4; 18, ♀ left pereopod 7.




FIGS. 19–24. *Asellus alaskensis*: 19, ♂ pleopod 2; anterior; 20, Tip of endopod of ♂ pleopod 2, anterior; 21–22, Same, posterior; 23, Same, lateral; 24, Exopod of ♂ pleopod 2, posterior. FIGS. 25–26, *Asellus aquaticus*, tip of endopod of ♂ pleopod 2: 25, Anterior; 26, Lateral. Abbreviations: c, capitulum; a.l., anterior lobe; f, fissure; l.s., labial spur.




FIGS. 27–31. *Asellus alaskensis*, anterior views of pleopods: 27, ♀ pleopod 2; 28, ♂ pleopod 1; 29, ♂ pleopod 3; 30, ♂ pleopod 4; 31, ♂ pleopod 5.

slightly longer than exopod, about twice as long as wide (width not including spur); curving gently laterally. Fissure bounded proximally by transverse sclerotized bar; medial lip of fissure with U-shaped labial spur connecting proximally with transverse bar. Anterior lobe low, broadly rounded, without medial spine present in *A. aquaticus*. Capitulum with central cannula, produced posteriorly into ledge and caudally into spinose lobe.

Female pleopod 2 oval, about 1⅔ times as long as wide, with about 15 plumose setae on distal and lateral margins. Pleopod 3 exopod about 1¼ times as long as wide, proximal segment about ⅔ length of distal segment. Exopods of pleopods 4 and 5 with about 15 and 8 setae respectively on proximolateral margins; exopod of pleopod 4 with a partial suture; both pleopods with double false suture distally in form of crescent.

Uropods about ¾ as long as pleotelson, not so slender and relatively shorter than in *A. latifrons*; armature of long and short setae as in Figure 9.

*Etymology*: The specific name, *alaskensis*, refers to the occurrence of the new species in the state of Alaska.

*Relationships*: The presence of 4 setae on the inner lobe of maxilla 1, the boss proximal to the palm on the male pereopod 1, and the rounded female pleopod 2, taken together, place the Alaskan species in *Asellus* (*Asellus*) as restricted by Henry and Magniez (1970). Within the subgenus, *A. alaskensis* and the west Siberian *A. latifrons* are set apart from the other species by having lateral head incisions and reduced coxae not visible in dorsal view. The male pleopod 2 endopod tip of *A. latifrons* is not illustrated in sufficient detail to permit a comparison of this taxonomically important structure in the 2 species, but it seems evident

from the overall similarity that *A. alaskensis* and *A. latifrons* are descendents of a common ancestor and have no close relatives among other species of *Asellus* (*Asellus*). They, as well as *A. epimeralis* Birstein from Lake Bount, exhibit certain characters that Birstein considered primitive because they are found in juveniles but not in adults of *A. aquaticus*: the large size of the rami in proportion to the protopod of the male pleopod 2; the elongate female pleopod 2; and the straight lateral margins of the exopod of the male pleopod 1, lacking the excavation of the adult *A. aquaticus*.

The wide taxonomic gap between *Asellus alaskensis* and other North American Asellidae has been referred to already. Other examples of Alaskan freshwater invertebrates with Eurasian rather than North American affinities can be cited, for example among the Turbellaria (Kenk, 1953) and the diaptomid Copepoda (Wilson, 1953).

*Terminology for endopod of ♂ pleopod 2*: American zoologists, beginning with Steeves (1963) and followed by Williams (1970, 1972) and Fleming (1972, 1973) have applied standard terms to the 4 or fewer elements forming the tip of the ♂ pleopod 2 endopod. The number and form of these elements have been given great weight in recent works on North American asellids and have formed the basis for proposed phylogenies, either wholly (Steeves, 1966) or in part (Williams, 1970). We have not attempted herein to apply Steeves' terms to *A. alaskensis* because homologies cannot be assumed between the Alaskan asellid and the species of *Conasellus*. In fact, the assumed homologies of the endopodal elements among species of *Conasellus* cannot be taken to have been proven beyond doubt.

Perhaps because this component species can be distinguished readily by other characters, consistent terms have not been applied to the structures of the endopod of the ♂ 2nd pleopod in *Asellus* (*Asellus*) species. We found it necessary, therefore, to devise the terms used in the above description of *A. alaskensis*. Our terms are listed below, together with those used by Maercks (1930) and Needham (1938) for the same structures in *A. aquaticus*.

| This paper | Maercks | Needham |
|---|---|---|
| basal spur | processus calcariformis or "Sporn" | spur |
| fissure | Spalt | opening of seminal cavity |
| labial spur | processus cylindriformis + Häkchen | conical spur, or head of hammer |
| anterior lobe | -------- | mobile lappet |
| capitulum | Spiralhaken | recurved distal tooth of lateral edge |

*Zoogeography and ecology*: Birstein (1951) interpreted the known present distribution of *Asellus* (*Asellus*) spp. in Siberia (Fig. 32) as

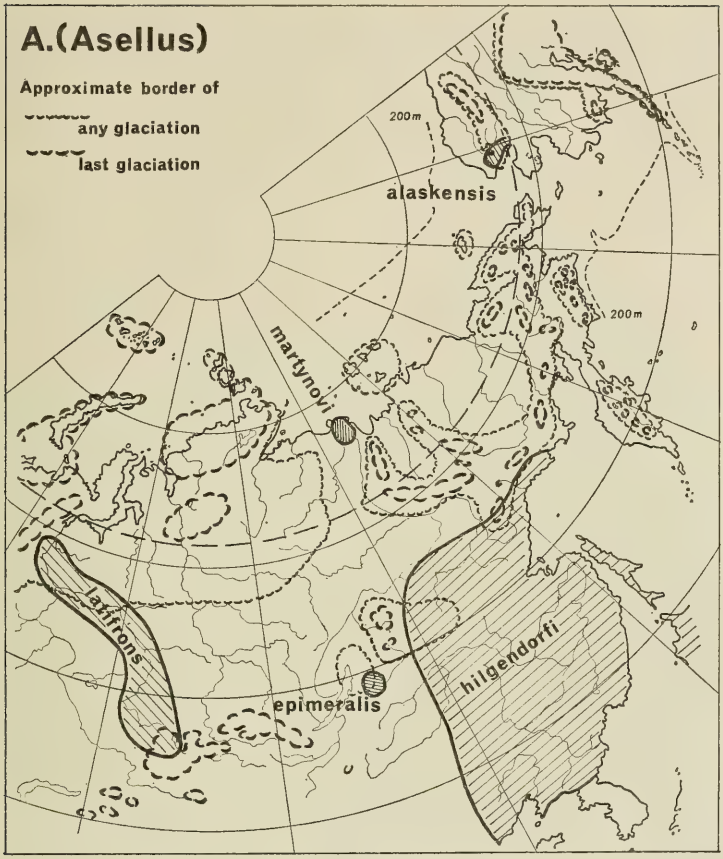



FIG. 32. Known distribution of epigean species of the subgenus *Asellus* in Asia and Alaska. Asian data based on Birstein (1951).

remnants of a vast continuous distribution in preglacial times. He believed that severe conditions associated with Pleistocene glaciation wiped out all but a few populations, namely *A. latifrons* in the Ob-Irtysh basin, *A. epimeralis* in Lake Bount, and *A. hilgendorfi martynovi* in the Lena delta.

With the discovery of *A. alaskensis*, Birstein's hypothesis would require the preglacial distribution to stretch nearly the entire distance across northern Siberia and across the Bering Strait into an area of Alaska on the north side of Kotzebue Sound. The Bering Strait presents no obstacle to this distribution, since the Bering Land Bridge was present during the early Tertiary until the late Miocene and again during most

of the Pleistocene (Hopkins, 1967). In preglacial times *A. latifrons* and *A. alaskensis* may have still been a single species, with the now remaining marginal populations beginning to diverge or having already differentiated as extremes of a variable species or as subspecies. Birstein would then have the Siberian glaciers of the Pleistocene exterminate the entire *latifrons-alaskensis* populations between the existing "relicts," i.e., over the vast extent of about 6100 km (3800 miles).

Birstein's hypothesis may prove to be correct—only time will tell—but it suffers from 2 major deficiencies. 1. It requires more intolerable conditions resulting from glaciation in northern Siberia than can be supported by the available evidence; 2. It assumes that the freshwater fauna of northern Siberia is well known, and that further collecting will not change the overall distribution patterns of Siberian *A.* (*Asellus*) spp.

As in other areas the exact extent of glaciation in Siberia is still somewhat obscure, but because there was less precipitation the ice sheets were less extensive and thinner than those in Europe and North America (Fig. 32; Charlesworth, 1957; Woldstedt, 1954–1965). Areas uncovered by snow and therefore dark would have absorbed much radiant heat during summers, and the many bodies of water acted as heat reservoirs during winters. Even so, conditions during glacial periods probably would have been severe enough to have eliminated some asellid populations, but other asellid populations might have survived. It is known that Alaskan lakes deeper than about 2 m generally do not freeze to the bottom (Brewer, 1958; Holmquist, 1973), and there must be many such lakes in Siberia. These lakes also have a layer of unfrozen ground beneath them; the thickness of this layer is correlated with the depth of the lake and the volume of unfrozen water in it. If only a little oxygen is present asellids should be able to survive in this layer of unfrozen water. *A. aquaticus* can survive up to 48 h without oxygen at a temperature of 16–20°C and normally requires only 0.4–0.5 mg/l (Levanidov, 1949). Even if a lake should freeze to the bottom it is possible that asellids might survive. Some invertebrates, including certain insect larvae and crustaceans, can withstand being frozen in ice (Scholander, Flagg, Hock and Irving, 1953), and although there is no evidence that asellids could survive such treatment, the possibility cannot be ruled out.

Although Birstein (1951) gave the impression that the distribution of asellids in northern Siberia is well known, there appear to be a number of unexplored areas where asellids might be expected to occur. A most useful summary of limnological investigations in the U.S.S.R. was given by Zhadin and Gerd (1963), and from this work one can get some idea of the extent of the areas not investigated for *Asellus*.

Moving eastward from the Ob basin, inhabited by *Asellus latifrons*, we find that nothing is said about the Pur and Taz Rivers. The authors listed 1 isopod in the Yenisei fauna, which must be *A.* (*Baicalasellus*) *angarensis* Dybowsky, which inhabits the upper reaches of the tributary Angara River as well as Lake Baikal. On the Taimyr Peninsula, Lake Taimyr has been studied and no asellids found, but the Pyasina and

Taimyr Rivers have not been investigated. No information is given about the bottom fauna of the Khatanga, Anabar, and Olenek Rivers. *Asellus hilgendorfi martynovi* Birstein (not mentioned by Zhadin and Gerd) inhabits lakes in the delta of the Lena River (Birstein, 1951). Zhadin and Gerd listed *A. aquaticus* from the middle reaches of the Lena, but this must be a misidentification, since *A. aquaticus* does not occur in Siberia. The bottom fauna of the Yana, Indigirka, and Kolyma Rivers have not been studied, nor has that of the Anadyr.

In addition to the foregoing major river systems, there are numerous uninvestigated shallow lakes in Siberia, and these may offer more favorable habitats for asellids than the deeper lakes and rivers that have received more attention from hydrobiologists.

The reason why *Asellus alaskensis* was taken only in 2 lakes of the western part of the Holmquist survey area is obscure. This survey was undertaken during 6 summers of the period 1961–1970. About 100 lakes were investigated over a large area, from about 129°33′ to 165° 41′W, and from about 65°07′ to 71°23′N (Holmquist, 1975). Huggins's collection (see above) comes from an area not very far from the 2 lakes mentioned, and the report by Watson, Davis and Hanson (1966) of an *Asellus* in the Cape Thompson area concerns the same northwestern part of Alaska.

Other invertebrates showing such a western occurrence are the oligochaetes *Alexandrovia onegensis* and *Styloscolex opisthothecus* (Holmquist, 1974a, 1974b). *A. onegensis* was taken in approximately the same area as *Asellus*, but it is known otherwise only from its type locality, Lake Onega in Europe. *S. opisthothecus*, a species originally described from localities on Kamchatka, was found in the survey area in 2 lakes slightly further north than *Asellus*. It belongs to a genus otherwise known from Japan, Manchukuo and Lake Baikal. These facts are apt to strengthen the significance of the Bering Land Bridge as a means of dispersal for freshwater invertebrates. They also emphasize the lack of knowledge of the freshwater fauna of vast northern areas.

Niglaktak Lake is fairly weedy. It is rather shallow (maximum depth noted, about 1.8 m) with the vascular plants consisting mainly of *Potamogeton* and *Myriophyllum*. On the first visit to this lake a great quantity of the blue-green alga *Gloeotrichia* was obtained in the net. The invertebrate fauna of the lake also seemed luxuriant. Among others, the above-mentioned oligochaete *Alexandrovia* was taken here. Inland Lake appeared equally shallow (maximum depth noted about 1.9 m) but less weedy. Only small fragments of *Potamogeton* were secured. The plankton seemed rich and varied, and the benthic fauna was varied.

Lakes of the Noatak valley are generally about as shallow. Such lakes may be presumed to warm up fairly quickly in this area, once the ice is gone from the surface. However, there is no protection from the frequent winds, which are apt to effectively stir up the water of these rather large lakes and thus moderate the heating rate. In the fall the winds are cool and presumably cause the whole body of water to cool

down close to freezing temperature before the surface is iced over, protecting the deeper parts from freezing. Thus, during the long winter a temperature between 1° and 4°C, but closer to the lower limit, is presumed for the benthic environment. At the end of the summer (22 August 1967) a temperature of about 14°C was measured in both lakes. Summer temperatures may be higher than those recorded during this survey. On September 19, 1970, water in Niglaktak Lake measured only 4°C. These facts may give some idea of the conditions under which *A. alaskensis* is living.

In summary, *Asellus alaskensis* and *A. latifrons* are descendants of a common ancestor that once ranged across the entire breadth of northern Siberia and into Alaska. The slight morphological differences between the 2 species may already have existed before Pleistocene glaciation or may have developed only after the Ob-Irtysh and Alaskan populations were isolated by extermination of intervening populations during Pleistocene glaciations. It is possible that at least some of the intervening populations were not wiped out during the Pleistocene but still exist in unstudied lakes and rivers, and even if further investigations should demonstrate the absence of intervening populations, this would not prove that they were eliminated during the Pleistocene. Isolation and speciation might have occurred much earlier.

## Acknowledgments

We are grateful to Dr. Huggins for the samples from the Noatak River drainage basin and to Dr. Winger for specimens from the Provo River. The samples from Niglaktak Lake and Inland Lake were collected during a survey sponsored by The Arctic Institute of North America with the approval and financial support of the Office of Naval Research, under contract N 00014-70-A-0219-0001 (subcontract ONR-412), and supported by the Naval Arctic Research Laboratory, Barrow, Alaska.

Dr. Roman Kenk kindly reviewed the manuscript.

## Literature Cited

Birstein, J. A. 1947. Water slaters of Siberia. Doklady Akademii Nauk SSSR 57(4):409–412 [in Russian].

———. 1951. Freshwater isopods (Asellota). Fauna SSR, Crustacea 7(5):1–140 [in Russian; English translation by Israel Program for Scientific Translation, 148 pp. 1964].

Bousfield, E. L. 1963. Investigations on sea-shore invertebrates of the Pacific coast of Canada, 1957 and 1959. I. Station list. Nat. Mus. Canada Bull. 185:72–89.

Bowman, Thomas E. 1974. The California freshwater isopod, *Asellus tomalensis*, rediscovered and compared with *Asellus occidentalis*. Hydrobiologia 44:431–441.

Brewer, Max C. 1958. Some results of geothermal investigations of permafrost in northern Alaska. Trans. American Geophys. Union 39:19–26.

Charlesworth, John K. 1957. The Quaternary Era, with special references to its glaciation. 2 volumes, 1700 pp. London.

Fleming, Laurence E. 1972. The evolution of the eastern North American isopods of the genus *Asellus* (Crustacea: Asellidae). Part I. Intern. Jour. Speleol. 4:221–256.

———. 1973. The evolution of the eastern North American isopods of the genus *Asellus* (Crustacea: Asellidae). Part II. Intern. Jour. Speleol. 5:283–310.

Henry, Jean-Paul, and Guy Magniez. 1970. Contribution à la systématique des Asellides (Crustacea Isopoda). Ann. Spéléol. 25(2):335–367.

Holmquist, Charlotte. 1973. Some arctic limnology and the hibernation of invertebrates and some fishes in sub-zero temperatures. Arch. Hydrobiol. 72(1): 49–70.

———. 1974a. A species of *Styloscolex* MICHAELSEN (Oligochaeta, Lumbriculidae) found in two lakes in northern Alaska. Int. Revue Ges. Hydrobiol. 59:49–55.

———. 1974b. On *Alexandrovia onegensis* HRABĚ from Alaska, with a revision of the Telmatodrilinae (Oligochaeta, Tubificidae). Zool. Jb. Syst. 101:249–268.

———. 1975. Lakes of northern Alaska and northwestern Canada and their invertebrate fauna. Zool. Jahrb. Abt. Syst. Oekol. Geogr. Tiere 102 (> 100 pp.) In press.

Hopkins, David M. 1967. The Cenozoic history of Beringia—a synthesis. In: Hopkins, D. M., editor, The Bering Land Bridge. 495 pp. Stanford University Press.

Kenck, Roman. 1953. The fresh-water triclads (Turbellaria) of Alaska. Proc. U.S. Nat. Mus. 103(3322):163–186.

Levanidov, V. J. 1949. The importance of allochthonous material in the water as a food supply for the water slater (*Asellus aquaticus* L.). Trudy Vesesoyuznogo Gidrobiologicheskogo Obshchestva [Trans. All-Union Hydrobiological Society] 1:100–117 [in Russian].

Maercks, Hans Helmut. 1930. Sexualbiologische Studien an *Asellus aquaticus* L. Zool. Jahrb. Abt. Allg. Zool. Physiol. 48:399–508, pl. 13.

Needham, A. E. 1938. Abdominal appendages in the female and copulatory appendages in the male *Asellus*. Quart. Jour. Microscop. Sci. 81:127–150.

Scholander, P. F., Walter Flagg, R. J. Hock, and Laurence Irving. 1953. Studies on the physiology of frozen plants and animals in the arctic. Jour. Cell. Comp. Physiol. 42, Suppl. 1:1–56.

Steeves, Harrison R., III. 1963. The troglobitic asellids of the United States: the *Hobbsi* group. American Midl. Nat. 71:445–451.

———. 1966. Evolutionary aspects of the troglobitic asellids of the United States: the *Hobbsi*, *Stygius*, and *Cannulus* groups. American Midl. Nat. 75(2):392–403.

Stammer, H. J. 1932. Zur Kenntnis der Verbreitung und Systematik der Gattung *Asellus*, inbesondere der mitteleuropäischen Arten (Isopoda). Zool. Anz. 99:113–131.

Watson, D. G., J. J. Davis, and W. C. Hanson. 1966. Terrestrial invertebrates. Pp. 565–584 *in* Norman J. Wilimovsky and John N. Wolf, eds. Environment of the Cape Thompson Region, Alaska, xvi + 1250 pp. U.S. Atomic Energy Commission, Division of Technical Information, Oak Ridge.

Williams, W. D. 1970. A revision of North American epigean species of *Asellus* (Crustacea: Isopoda). Smithsonian Contrib. Zool. 49:1–80.

———. 1972. Freshwater isopods (Asellidae) of North America. Biota of Freshwater Ecosystems Identification Manual No. 7: ix + 45 pp. Water Pollution Control Research Series, Environmental Protection Agency, Washington, D.C.

Winger, Parley V., Edward J. Peters, Michael J. Donahoo, James A. Barnes, and David A. White. 1972. A checklist of the macroinvertebrates of the Provo River, Utah. Great Basin Naturalist 32(4):211–219.

Wilson, Mildred S. 1953. Some significant points in the distribution of Alaskan fresh-water copepod Crustacea. Proc. Second Alaskan Sci. Conf. (1951):315–318.

Woldstedt, Paul. 1954–1965. Das Eiszeitalter. Grundlinien einer Geologie des Quartärs. 1–3. Stuttgart.

Zhadin, P. I., and S. V. Gerd. 1961. Fauna and flora of the rivers, lakes and reservoirs of the U.S.S.R. State Training and Pedagogical Literature Publishing House, Moscow, 599 pp. [in Russian; English translation by Israel Program for Scientific Translations, 626 pp., 1963].

3

QH
1
B4X
NH

8, pp. 73–76 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# MORE VARIANTS OF *SCAEVOLA TACCADA* (GOODENIACEAE) HAWAIIAN PLANT STUDIES 43

By Harold St. John
*B. P. Bishop Museum, Honolulu, Hawaii 96818*

The commonest marine beach shrub in the Hawaiian Islands is the "naupaka kahakai" or *Scaevola* sp. It thrives on rock, or soil of gravel, sand, clay, or loam, and it extends inland where the salt spray and marine influence does. As on many other tropical shores, there are two recognized variations: *S. Taccada* (Gaertn.) Roxb., var. *Taccada* which has its leaves glabrous, and its calyx lobes 2–3 (–4) mm long, 0.3–0.5 (–1) mm wide, lanceolate to linear. This is on all of the islands of the Leeward Islands, Hawaiian Islands, and it is also present on Kauai.

The var. *sericea* (Vahl) St. John differs by having its leaves sericeous. This variety is infrequent on the Leeward Islands, but it has been collected on Ocean, Midway, Laysan, and French Frigates. It is also present and abundant on all of the main islands of the Hawaiian group, and it is the only one on Niihau, Oahu, and the Hawaiian Islands to the south.

In the uplands of the Hawaiian Islands, there are recognized about 11 species and numerous varieties and hybrids of the genus, all of them endemic. It is assumed that they have evolved from the pantropic marine beach species. These upland ones are quite different in appearance, having the fruit smaller and black, and the corollas white, blue, or yellow. Nevertheless, *S. Taccada* is looked upon as the logical ancestor of these local endemics.

On Kauai, the maritime species extends inland and upland to a conspicuous degree. This was noted, and upland specimens of it were collected in 1909 by Urbain Faurie, in 1909 and

1916 by C. N. Forbes, in 1927 by L. H. MacDaniels, in 1933 by H. St. John, and in 1961 by O. & I. Degener. These collections were mostly made in southern Kauai, near Lihue, on the Haupu (or Hoary Head) Range, a line of jagged mountains running directly inland. Most of the collections were made at Kahoaea, or the Knudsen Gap, a pass at 500 ft altitude, 5½ mi inland. Here, at the lower edge of the forest, among trees of *Metrosiders collina*, and with *Dicranopteris linearis*, the species abounds and makes vigorous bushes 1–3 m tall. It follows along the range at least to Laaukahi and to an elevation of 1,300 ft. Its leaves are thinner and of a brighter green than that of the usual coastal varieties. Because of their distinctive differences these plants are here made a new variety, though they have had other placements.

*Scaevola Taccada* (Gaertn.) Roxb., var. *Fauriei* (Lévl.) comb. nov.

*S. Fauriei* Lévl., Fedde Repert. 10:150, 1911.

*S. sericea* Vahl, var. *Fauriei* (Lévl.) Deg. & Deg., Phytologia 6:321 1958.

*S. sericea* Vahl, var. *Fauriei* (Lévl.) Deg. & Deg., forma *saintjohnii* Deg. & Deg., Taxon 10:227, 1961.

*Original diagnosis*: "Rami arcuati, teres, striati, brunei; folia oblongo-spathulata, obtusissima, glabra, flaccida, ciliata, in petiolum alatum longe attenuata, 10–16 × 4–5 cm; inflorescentiae cymosae et axillares 2–3 cm ad basin plumoso-villosae; pedunculi et pedicelli pubescentes; dentibus calycinis anguste lanceolatis, acuminatis persistentibus; drupa glabosa (sic)."

*Diagnostic differences*: Leaves glabrous as in the species, but the calyx lobes 3.5–6 mm long, linear, glabrous.

*Holotype*: Hawaiian Islands, Kauai, Koloa, dec. 1909, *Faurie 651* (P). Type examined. Isotype (A).

*Specimens examined*: Hawaiian Islands, all from Kauai Island, Omoe, in woods on both sides of terminal ridge, Mar. 16, 1961, O. & I. Degener 27,313 (NY, BISH), (holotype of *S. sericea*, var. *Fauriei f. saintjohnii*); Honopu near Lihue, on very tip of ridge, July 9, 1909, C. N. Forbes 31.K (BISH); Moloaa Gulch, 4½ mi from the sea, 750 ft elev., Oct. 9, 1916; Forbes 554.K (BISH); Haupu, Lihue, top of ridge, July 9, 1909, Forbes 31.K (BISH); Waioli Valley, in uluhi fern (*Dicranopteris linearis*), 2½ mi from the sea, 50 m alt., Feb. 27, 1929, L. H. MacDaniels 904 (BISH); Haupu, Kipu, reforested area, 500 ft alt., Dec. 25, 1933, H. St. John & F. R. Fosberg 13,634 (BISH); Laaukahi, Koloa, grassy slope and in woods with *Metrosideros* and *Pandanus*, 900–1,300 ft alt., Dec. 22, 1933, St. John & Fosberg 13,464 (BISH);

Hanakapiai, Napali Coast, in *Pandanus* forest, Dec. 31, 1930, St. John et al. 10,906 (BISH).

*Discussion*: This *Scaevola* has invaded the uplands in several places on the south side (leeward) along the Haupu Range, and on the north side (windward) in Waioli Valley, and at Hanakapiai.

This upland, inland variety may well represent the connecting link between the maritime, halophytic species and the upland endemic ones.

*Scaevola Taccada* (Gaertn.) Roxb., var. **Bryanii** var. nov.

*Diagnosis holotypi*: Folia glabra sunt, lobis calycis 4–5 mm longis 2–2.5 mm latis ellipticis glabris.

*Diagnosis of holotype*: Leaves glabrous; calyx lobes 4–5 mm long, 2–2.5 mm wide, elliptic, glabrous.

*Holotypus*: Hawaiian Leeward Islands, Midway Island, Sand Island, 4–8 ft high, on the sand mounds, Aug. 21, 1902, W. A. Bryan (BISH).

*Discussion*: This new variety is closely related to S. *Taccada* (Gaertn.) Roxb., var. *Taccada*, but that typical variety has the calyx lobes 2–3 mm long, and 0.5–1 mm wide.

The variety *Bryanii* is named for its collector, William Alanson Bryan (1875–1942), professor of zoology and geology in the College of Hawaii, Honolulu; curator of ornithology, B. P. Bishop Museum; author of "Natural History of Hawaii," 1915.

QH
1
B4X
NH

9, pp. 77–90 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# A RECONSIDERATION OF SOME CUBAN *TROPIDOPHIS* (SERPENTES, BOIDAE)

By Albert Schwartz and Orlando H. Garrido
*Miami-Dade Community College, Miami, Florida 33167 and Academia de Ciencias de Cuba, Instituto de Zoología, La Habana, Cuba*

The most recent treatment of the small Cuban members of the boid genus *Tropidophis* is that of Schwartz and Marsh (1960). They recognized four species of these multispotted boas: *pardalis* Gundlach, 1840; *maculatus* Bibron, 1840; *pilsbryi* Bailey, 1937; *nigriventris* Bailey, 1937. In addition to these species, Cuba also is inhabited by other, either larger or quite differently patterned, *Tropidophis*: *melanurus* Schlegel, 1837; *semicinctus* Gundlach and Peters, 1865; *wrighti* Stull, 1938, *feicki* Schwartz, 1957. Schwartz and Marsh (1960: 72–74) also discussed four questionable Cuban specimens in American collections; one of these they assigned to *Tropidophis canus* Cope (a species that is otherwise Bahamian; the presumed Cuban specimen may be mislabeled as to provenance). The three remaining snakes Schwartz and Marsh considered representative of *Tropidophis haetianus* Cope, a widespread Hispaniolan species which had not been previously reported from Cuba. Thus, Cuba has at least nine species of *Tropidophis*, whereas no other Antillean island with these small boas (Hispaniola, Jamaica, Cayman Islands, Navassa Island, Bahama Islands, Caicos Islands) has more than one species.

Through the efforts of the junior author, specimens from various collections in Cuba have gradually been assembled in the Instituto de Zoología (IZ), Academia de Ciencias de Cuba. As this material accumulated, Garrido felt that addi-

tional specimens of one of the less well-known smaller boids (*T. pilsbryi*) was included among material previously identified as the widespread *T. pardalis*. In addition, there was a specimen which could not be easily identified as any known taxon. These specimens were sent to Schwartz, who borrowed pertinent material of this complex from the following collections: American Museum of Natural History (AMNH), Academy of Natural Sciences of Philadelphia (ANSP), Cleveland Museum of Natural History (CMNH), Museum of Comparative Zoology (MCZ), Museum of Zoology, University of Michigan (UMMZ), and National Museum of Natural History (USNM). These specimens, the IZ material, and specimens given to Schwartz by George R. Zug, now in the Albert Schwartz Field Series, comprise the suite of snakes examined. We wish to thank Richard G. Zweifel, George W. Foley, Edmond V. Malnate, William E. Scheele, Patricia Helwig, Ernest E. Williams, Arnold G. Kluge, George R. Zug, and Ronald I. Crombie for the loans of specimens, Fred G. Thompson for pointing out to the senior author the existence of the CMNH specimen, and Pastor Alayo for collecting specimens for the junior author. Our concepts of *T. pardalis* have been greatly influenced by the series of 44 snakes from Marianao, Habana Province, taken by Bruce B. Collette. This is the longest series of any of these small boids from a single locality.

To summarize distributional data (Fig. 1) on the three species considered in the present paper: *T. pardalis* occurs throughout the Isla de Pinos and Cuba (but is known from only one locality—San Germán in Oriente Province); *T. pilsbryi* is known from a series of localities in and near the Sierra de Trinidad in Las Villas Province, and from Oriente Province (Cayo del Rey, Miranda; Guantánamo); *T. nigriventris* occurs in the lowlands near the Sierra de Trinidad and in eastern Camagüey Province (Martí; 24 km SW Camagüey). Theoretically, all three species should occur syntopically, since their ranges are apparently to some extent sympatric. However, *T. pardalis* and *T. pilsbryi* are known sympatrically only from Soledad, Las Villas Province, and *T. pardalis* and *T.*

FIG. 1. Cuba, showing the distribution of three species of *Tropidophis*. Solid circles, *T. pardalis*. Squares: *T. pilsbryi*; open squares, *T. p. pilsbryi*; solid squares, *T. p. galacelidus*; semi-solid square, "*T. p. galacelidus*" from La Asunción. Triangles: *T. nigriventris*; open triangles, *T. n. nigriventris*; solid triangles, *T. n. hardyi*.

*nigriventris* also occur together at Soledad. In both these cases, actual syntopy requires confirmation.

Schwartz and Marsh (1960) discussed the variation in these small boas; we will not repeat their detailed discussion. Briefly, the three species may be distinguished as follows: *T. pardalis* usually has 6 rows of blotches around the body, is small in size (maximum total length 315 mm in males, 303 mm in females), lacks prominent pale occipital spots, has dorsal scales usually smooth, modally 2/2 postoculars, and modally 23 scale rows at midbody; *T. nigriventris* usually has 8 rows of blotches around the body, is large in size (maximum total length in males about 351 mm, 367 mm in females), lacks prominent pale occipital spots but may have an extensively dark venter, has dorsal scales smooth, modally 2/2 postoculars, modally 23 scales at midbody, and has the head notably smaller when compared to that of *T. pardalis*; *T. pilsbryi* has either 8 (Oriente) or 10 (Las Villas) rows of blotches around the body, is large (judging from females) in size (maximum total length in males 213 mm, in females 374 mm), has a prominent pair of pale occipital spots at times fused into a complete pale occipital collar, has keeled dorsal scales, modally 3/3 postoculars, and modally 25 scales at midbody. From these brief diagnoses, one can readily observe that *T. pilsbryi* differs conspicuously in having pale occipital spots or a pale collar, a feature which is absent in *T. nigriventris* but which occurs as a variant in Isla de Pinos and western Cuban *T. pardalis*, where the spots may be present but are never so prominent and contrasting as are those of *T. pilsbryi*.

We are convinced that the three nominal species recognized by Schwartz and Marsh are distinct. Recently gathered specimens of *T. pilsbryi* in the IZ from Las Villas and Oriente Provinces and specimens of *T. nigriventris* previously unstudied in the USNM from Las Villas Province, as well as reconsideration of one of the questionable specimens (USNM 137084) and other material formerly available to Schwartz and Marsh, all help to amplify the variation in these two species. In addition, a single snake (IZ 1246) from El Babiney north of Monte Líbano, Oriente Province, is of interest. In the following descriptions, we admit that we may have over-

simplified a complex problem by electing to name new taxa as subspecies rather than species, since in both cases the ranges as presently known seem broadly disjunct, and the taxa involved are completely separable from each other. However, it seems presently preferable to follow this philosophy rather than name these taxa as new species. Still, the hiatuses and other complexities in distribution might suggest specific, rather than subspecific, status.

Bailey (1937:42) named *Tropidophis maculatus pilsbryi* from three specimens from widely separated localities: Cayo del Rey near Miranda (type-locality) and Guantánamo, both in Oriente Province, and Mina Carlota in the Sierra de Trinidad in Las Villas Province. The holotype (ANSP 20822) has 164 ventral scales (as counted by the method proposed by Dowling, 1951) and the Guantánamo specimen (MCZ 9884) has 166 ventrals; the Mina Carlota snake (UMMZ 65043), on the other hand, has 178 ventrals. In addition, the two Oriente snakes have 8 rows of blotches around the body, whereas the Las Villas snake has 10 rows. Four recently taken specimens from these two general areas plus two previously secured snakes confirm these differences, and accordingly we name the Las Villas populations as follows:

**Tropidophis pilsbryi galacelidus**, new subspecies

*Holotype*: IZ 4052, from near Cafetal de Gaviña, Sierra de Trinidad, Las Villas Province, Cuba, taken 9 July 1973 by Pastor Alayo.

*Paratypes*: IZ 1075, Pico de Potrerillo, Trinidad, Las Villas Province, Cuba, June 1955, P. Alayo; UMMZ 65043, Mina Carlota, Las Villas Province, Cuba, 19 March 1925, E. R. Dunn; USNM 137084, Soledad, Las Villas Province, Cuba, December 1954, J. D. Hardy; CMNH 1021, Guabairo, Las Villas Province, Cuba, 23 March 1941, P. N. Moulthrop.

*Definition*: A subspecies of *T. pilsbryi* characterized by a greater number of ventral scales (177–183 versus 160–166 in *T. p. pilsbryi*), 10 rows of blotches around body at midbody, more blotches (44–50; $\bar{x} = 47.8$) in the paramedian series than in the nominate subspecies (36–47; $\bar{x} = 39.5$), and 25 or 27 scale rows at midbody (in contrast to 23, 24, or 25 in *T. p. pilsbryi*).

*Description of holotype*: A male with snout-vent length of 187 mm, tail length 26 mm (total length 213 mm), 177 ventral scales, 35 unpaired subcaudal scales, 10/10 supralabials, 12/12 infralabials, 1/1 preoculars, 3/3 postoculars, dorsal scales keeled and in 25-25-19 rows, 48/44 blotches

in paramedian dorsal blotch rows, arranged in 10 longitudinal series at midbody, parietal scales not in contact. As preserved, dorsal ground color medium gray, blotches black, blotches in paramedian series largest (each encompassing about 4 to 6 scales), ventralmost series on each side confined to ventral scales and first dorsal scale row; a prominent white collar representing fused pair of occipital spots, collar constricted medially and about 8 dorsal scales long at its maximum length; upper surface of head with more or less rectangular darker gray figure, its sides slightly concave, diffuse on snout and abutting against white collar posteriorly; supralabials pale gray; infralabials, chin and throat pale gray, grading to white venter invaded about midbody by lateralmost blotch series so that in some instances blotches slightly join each other; tail tannish yellow above, clear yellow below, with black tip.

*Variation*: The series of *T. p. galacelidus* consists of the holotypic male and four females ranging in total length from 183 mm to 459 mm, in tail length from 22 mm to 54 mm. One specimen (IZ 1075) is decapitated, but its collector stated that there was a white nuchal pattern, and the ventral count of the specimen (178+) as well as the size of the dorsal blotches and the presence of 10 rows at midbody assures us that this individual is indeed assigned to this taxon. In the entire series, ventrals range from 177 to 183, subcaudals from 29 to 35; supralabials either 10 or 11, and infralabials either 11 or 12; parietal scales not in contact in any specimen; preoculars 1/1 and postoculars 3/3 in all snakes; dorsal scales regularly keeled above vent, less prominently so elsewhere on body; scale rows behind head usually 25 (one with 27), at midbody 25 (three specimens) or 27 (two), and anterior to vent 19 (one with 20). The blotches are arranged in 10 longitudinal series in all individuals, and the paramedian blotch series vary between 44 and 50 ($\bar{x} = 47.9$); the dorsal surface of the tail has from 4 to 9 blotches and is pale ventrally in all specimens except USNM 137084, whose tail is incomplete. In color and pattern the paratypes resemble the holotype except that in IZ 1075 the dorsal pattern is less obvious, and in USNM 137084 and CMNH 1021 the dorsal color is more brown and the blotches darker brown but not especially conspicuous. Large individuals have scattered pale scales associated with at least the paramedian blotch rows.

*Comparisons*: The two subspecies of *T. pilsbryi* are easily distinguished on the basis of number of ventral scales (177–183 in *galacelidus*, 160–166 in *pilsbryi*), presence of 8 rows of blotches in *pilsbryi* and 10 in *galacelidus*, and a higher number and mean of paramedian blotches in *galacelidus* (44–50; $\bar{x} = 47.9$) than in *pilsbryi* (36–47; $\bar{x} = 39.5$). In addition, *galacelidus* has either 25 or 27 scale rows at midbody, whereas in *pilsbryi* midbody scales are 23, 24, or 25. Both subspecies have a prominent pair of pale occipital blotches or a collar. The blotches are fused in two *galacelidus* (UMMZ 65053, IZ 4052) and in two *pilsbryi* (MCZ 9884, USNM 12361). Like *galacelidus*, specimens of *pilsbryi* lack

parietal contact. Two *pilsbryi* (IZ 1076–77) have 3/2 postoculars, a condition not observed in *galacelidus*.

*Remarks*: USNM 137084 is one of the four specimens which Schwartz and Marsh were unable to locate taxonomically. They stated (1960:73) that this snake had occipital spots, and thus might well have been considered *T. pilsbryi*. However, the spots are less well defined than in all other *T. pilsbryi*, and the size of the snake (total length 374 mm) in comparison with other *T. pilsbryi* available to them (maximum 183 mm), combined to obscure its affinities. The even larger CMNH specimen (total length 459 mm) also has obscure occipital spots. We imagine that these spots become more obscure with age (and increasing size), but they are nevertheless a constant feature (albeit faint in large adults) of *T. pilsbryi*.

The distribution of *T. p. galacelidus* centers in the Sierra de Trinidad in Las Villas Province. Three specimens (from Mina Carlota, Pico de Potrerillo, and Cafetal de Gaviña) are all from within this range, and the specimen from Soledad is from near the foot of the Sierra de Trinidad and may well have been taken within the mountains themselves. Guabairo also is near the base of this range.

Comparisons of *T. p. galacelidus* with *T. pardalis* and *T. nigriventris* will be made below in the present paper. The name *galacelidus* is from the Greek for "milk" and "spot," in allusion to the white occipital markings.

*Tropidophis p. pilsbryi* is now known from four localities in Oriente Province, of which one is vaguely "eastern Cuba." The closest approximation of the two subspecies is about 440 kilometers, across all of Camagüey Province and well into Oriente Province. Whether the species occurs in this hiatus remains unknown. In Oriente, *T. p. pilsbryi* seems to be widely distributed, from Miranda east to Guantánamo, but the localities whence this subspecies is known may also be forested uplands as appears to be the case with *T. p. galacelidus*.

We have deliberately not designated as a paratype a *T. p. galacelidus* (IZ) from La Asunción, Baracoa, Oriente Province. This specimen is a young female (snout-vent length 144 mm) with a pair of pale occipital spots, 177 ventrals, 29 subcaudals, 10/10 supralabials, 11/12 infralabials, lack of parietal contact, 1/1 preoculars, 3/3 postoculars, smooth dorsal scales in 25-27-19 rows, and 8 rows of dark blotches with 38/35 blotches in the paramedian series. In every way, this specimen agrees with our concepts of *T. p. galacelidus* and not with adjacent *T. p. pilsbryi*. The geographic hiatus between this specimen and the nearest *T. p. galacelidus* is about 575 km, yet *T. p. pilsbryi* is known from a locality only about 70 km distant. There is no question that the locality of this specimen is correct. We would have no reluctance in assigning this snake to *T. p. galacelidus* were it not for the extensive geographic gap between it and that subspecies and the proximity of the range of *T. p. pilsbryi*. The gap between La Asunción and Trinidad encompasses much of Las Villas Province, all of Camagüey Province, and almost all of Oriente Province;

this of itself is in no way prohibitive, but the absence of specimens from this entire region makes the subspecific status of the La Asunción snake problematical. The absence of *T. pilsbryi* from much of the intervening region is by no means affirmed, and the species may persist there in suitably forested situations. On the other hand, it is possible that there is another isolated population, differing in some details from both *T. p. pilsbryi* and *T. p. galacelidus*, in extreme northeastern Oriente Province. Still another possibility is that *T. p. pilsbryi* and *T. p. galacelidus* are distinct species, a possibility that we are presently unwilling to accept.

*Specimens of T. p. pilsbryi examined*: Cuba, Oriente Province, Cayo del Rey, near Miranda (ANSP 20822, holotype); Santa Faz, near San Vicente (IZ 1076-77); Guantánamo (MCZ 9884); "eastern Cuba" (USNM 12361).

In the introduction to the present paper we mentioned a single questionable specimen from El Babiney, Hoyo del Río Guaso, to the north of Monte Líbano, hydroelectric plant, road to Las Ninfas, Guantánamo, Oriente Province. This snake (IZ 1246) is from the Ramsden collection and was collected 17 February 1921. It is indeed a puzzling snake. It is a male with a snout-vent length of 310 mm, tail 40 mm. There are 165 ventral scales and 26 subcaudals, 1/1 preoculars, 3/3 postoculars, parietals not in contact, the dorsals are smooth, and the scale row formula is 25-23-19. The dorsal blotches are in 8 rows and there are 41/40 paramedian blotches on the body and 5 on the tail. The number of ventral scales (167) eliminates *pardalis* (ventrals 136–155) and *maculatus* (189–208) from consideration. The ventral number falls within the range of *nigriventris* from Las Villas Province (153–172) but not from adjacent Camagüey Province (144–150). The ventral count does fall within the parameters of *T. p. pilsbryi* and the snake agrees with our concept of that taxon except that it now lacks any clear-cut indication of pale occipital blotches. The occipital area is no paler than the balance of the dorsal ground color; but this region is clear and unmarked, suggesting that in life the occipital area may well have been pale. A label in Ramsden's writing identifies the snake as *T. maculatus*, but it surely is not that species; perhaps a factor which caused Ramsden's assignment of this snake to *T. maculatus* is that that species does not occur further east in Cuba than Habana Province. It is possible that Ramsden, who lived in Oriente, had never seen specimens of *T. maculatus* and, realizing that this specimen was different from any other local *Tropidophis*, considered it *maculatus*.

We had ourselves at first considered that IZ 1246 was another Cuban specimen of *T. haetianus* Cope, but the scale counts and other characteristics eliminate that species from consideration. It seems most likely that this is a peculiarly patterned *T. pilsbryi* or one whose pale occipital blotches have faded during preservation. Another possibility which should not be dismissed is that it represents still another species of

dwarf boa from eastern Cuba, but militating against this is the fact that adult specimens of *T. pilsbryi galacelidus* have the occipital blotches obscured, but much more obvious than in this individual; all specimens of the nominate subspecies have the occipital blotches very prominent, and a maximally sized specimen has a snout-vent length of 181 mm, thus is much smaller than IZ 1246.

*Tropidophis pardalis* is a widespread Cuban species that occurs throughout Cuba (with the exception of most of Oriente Province, where it is known only from San Germán) and the Isla de Pinos. It presents a uniformity of pattern, size and scale counts throughout much of its range, except that some Pinar del Río and Isla de Pinos specimens show indications of pale occipital spots. We now have counts on 106 *T. pardalis.* The ventral scales vary between 136 (Habana Province) and 155 (Isla de Pinos); the largest male has a total length of 315 mm (Isla de Pinos) and the largest female 303 mm (Habana Province). The rows of dark body blotches are modally 6, with 8 rows occurring occasionally in extreme western snakes. Dorsal scale rows at midbody are either 23 (mode) or 25. In general aspect, then, *T. pardalis* is a small snake with 6 rows of large and conspicuous blotches and usually 23 scale rows at midbody.

There remain eight snakes in the USNM and the AMNH which are from the area between Soledad and Trinidad in extreme southern Las Villas Province. Of them, Schwartz and Marsh examined two (AMNH 77784, UMMZ 76109—both from Soledad) and considered them *T. pardalis.* These two specimens, however, have relatively high ventral counts (153, 155) for that taxon. The additional six specimens agree with these two snakes in large size and in having even higher scale counts (161–172), and we group them together.

We feel confident that these eight snakes represent a new taxon, distinct at some level from *T. pardalis.* The options are these: 1) the extreme southern coast of Las Villas Province is inhabited by a local subspecies of *T. pardalis* which is large and has high ventral counts, 2) these snakes represent a species distinct from not only *T. pardalis* but all other Cuban *Tropidophis*, or 3) they are allied to another named species other than *T. pardalis.* We cannot refute or confirm any of these possibilities; specimens of *T. pardalis* from elsewhere in Las Villas Province are very few and from only two localities (La Sierra, N of Vega Alta; Cumanayagua), and these snakes seem typical of *T. pardalis* in size, ventral counts, and pigmental and pattern characteristics. One feature which is dis-

tinctive is the fact that the eight snakes, at both comparable and larger sizes than *T. pardalis*, have relatively smaller heads. Schwartz and Marsh (1960:79) assigned two of these snakes (USNM 138512, USNM 138510) to *T. nigriventris*; however, they commented (p. 70) that the two Las Villas snakes differed from Camagüey material, including the holotype description and the paratype, in not having the venter almost entirely dark, a distinguishing feature of Camagüey *T. nigriventris* and indeed of the species. They stated (*loc. cit.*) that the major differentiating feature of the two species (*T. pardalis* and *T. nigriventris*) "is the much smaller head of *nigriventris*; if specimens of the two taxa are compared, the smaller head of *nigriventris* is immediately apparent." For this reason, we feel most inclined to regard these southern Las Villas snakes as a subspecies of *T. nigriventris*, despite the apparent hiatus between them and the nominate subspecies. Accordingly, in honor of Jerry D. Hardy, who collected the majority of the specimens, we propose the following combination:

**Tropidophis nigriventris hardyi**, new subspecies

*Holotype*: USNM 138510, an adult male, from 10 mi. (16 km) W Trinidad, Las Villas Province, Cuba, taken 5–10 September 1956 by J. D. Hardy.

*Paratypes*: USNM 138511-12, same data as holotype; USNM 140471-72, near Trinidad, Las Villas Province, Cuba, 23–27 June 1957; USNM 137085, Trinidad, Las Villas Province, Cuba, 23 December 1954, J. D. Hardy; UMMZ 76109, Soledad, Las Villas Province, Cuba, 18 July 1933, N. A. Weber; AMNH 77784, Soledad, Las Villas Province, Cuba, 18 July 1957, W. H. Gehrmann.

*Definition*: A subspecies of *T. nigriventris* characterized by high number of ventral scales (153–172 versus 144–150 in *nigriventris*), 6 or 8 (modally 6) rows of blotches around body at midbody, and venter never extensively dark brown to blackish because of greatly enlarged ventrolateral rows of blotches across venter as in nominate subspecies.

*Description of holotype*: A male with snout-vent length of about 303 mm, tail about 48 mm (total length about 351 mm), 170 ventral scales, 33 unpaired subcaudal scales (tail incomplete), 10/? supralabials, 11/? infralabials, 1/1 preoculars, 2/2 postoculars, dorsal scales smooth and in 21-23-18 rows, 40/41 blotches in paramedian dorsal blotch rows, arranged in 8 (incomplete) rows at midbody, parietal scales not in contact. As preserved, dorsum medium brown with dark blotches darker brown, ventrolateral rows of blotches on each side not expanded midventrally to give basically all-dark venter; top of head dark and patternless; venter

white, chin and throat dark brown; upper labials dark brown, separated by an almost black loreal stripe from brown top of head; tail dark brown above with about 6 dorsal blotches, ventrally with about 13 partially paired or staggered dark blotches on white ground; no indication of any pale occipital markings.

*Variation*: The series of *T. n. hardyi* consists of three males and five females; the largest male has a snout-vent length of 303 mm (USNM 138510), the largest female 334 mm (USNM 140472). The incomplete tail of the male measures 33 mm, that of the female 21 mm (also incomplete). The ventrals in the entire series range from 153 to 172, and specimens of both sexes with complete tails have subcaudals varying between 31 (male) and 46 (female); one female with an incomplete tail has 48 subcaudals. The supralabials are 9/9 (two snakes), 9/10 (three) and 10/? (one). Infralabials are 9/9 (one snake), 9/10 (one), 10/10 (one), 10/11 (one), 11/11 (one), and 11/? (one). The parietal scales are not in contact except in one snake (USNM 140471). Preoculars are 1/1 in all specimens which can be counted and postoculars are either 2/2 (five specimens), 2/3 (one), or 3/3 (one). Dorsal scales are smooth in all snakes except UMMZ 76109 where they are slightly keeled. Scale rows behind the head are 20, 21, 23 or 24 (mode 21), at midbody 23 or 25 (mode 23—seven snakes), and anterior to vent 18, 19, or 20 (mode 19). The modal dorsal scale row formula is 21-23-19. The blotches are arranged in 6 rows in six specimens and in 8 rows in two; in these latter snakes, the lowermost rows are obsolete, and one of the lateral rows on each side is weakly indicated; paramedian blotches range from 32 to 44 ($\bar{x} = 37.8$); the dorsal surface of the tail has from 4 to 6 dark blotches (the high count is from a snake with an incomplete tail). The dorsal ground color is medium brown to dark brown, and the venter white to pale tan, in all specimens. The rows of blotches are dark brown and conspicuous, although the ventrolateralmost rows may be obsolescent and the median lateral row may also be present (although it is absent completely in all but two snakes). In large snakes the head is conspicuously small, and the same condition is obvious but somewhat less so in smaller individuals. The upper surface of the head is unpatterned, except that at times there is a vague, longitudinal, dark rectangular figure; the supralabials are tan and set off sharply from the dorsal ground color of the head.

*Comparisons*: *Tropidophis n. hardyi* differs from *T. n. nigriventris* in two obvious ways: 1) the number of ventrals in *hardyi* is greater (152–172) than in *nigriventris* (144–150), and 2) *nigriventris* has the ventralmost blotch rows large and expanded, so much so as to render the venter almost totally dark due to random blotch fusions across it. One *hardyi* (AMNH 77784) tends slightly toward this latter condition, but all other specimens do not demonstrate it at all; in fact, the ventralmost rows are often obsolete. The dark venter in nominate *nigriventris* is not ontogenetic, since the condition occurs in snakes with snout-vent

lengths of 162 mm and 184 mm, much smaller than any *hardyi*, in which subspecies the venter never has this hypermelanic condition. There is no problem differentiating *hardyi* from *nigriventris*; what is problematical is whether *hardyi* should be associated with it nomenclaturally. One feature is suggestive: both populations have distinctly smaller heads than, for instance, *T. pardalis*. The larger size of *hardyi* suggests that this subspecies is indeed a larger snake than *nigriventris*, but the samples in each case are small. It is intriguing, however, that all *nigriventris* are small (maximum snout-vent length 227 mm) whereas all *hardyi* are large (minimum snout-vent length 184 mm); the latter subspecies reaches a maximum snout-vent length of 334 mm.

More pertinent than comparisons of *T. n. hardyi* with *T. n. nigriventris* are comparisons of *T. n. hardyi* with *T. pardalis* and *T. pilsbryi*. Of these two species, *T. pardalis* has been taken sympatrically with *T. n. hardyi* at Soledad (USNM 134353), and *T. pilsbryi galacelidus* is also known from Soledad, as well as Guabairo which is within a few kilometers of Soledad. In the Sierra de Trinidad, *T. p. galacelidus* may approach *T. n. hardyi* closely, since the latter seems to be (Trinidad) a lowland snake, whereas the former seems to occur in the more mesic uplands.

*Tropidophis n. hardyi* differs from *T. p. galacelidus* in lacking pale occipital blotches, in having fewer ventral scales (153–172 versus 177–183), in having 6 (rarely 8) rows of blotches rather than 10, and in having fewer paramedian blotches (32–44 versus 44–50). Both taxa reach about the same size, but there is no difficulty in separating them.

Differentiating between *T. n. hardyi* and *T. pardalis* is more difficult. Ventrals in the long series of *T. pardalis* vary between 136 and 155, whereas this count in *T. n. hardyi* varies between 153 and 172. The high counts of ventrals in *T. pardalis*, however, are not from Las Villas Province, but rather from the Isla de Pinos and Habana Province. The largest male *T. pardalis* has a total length of 315 mm and the largest female 303 mm, in contrast to *T. n. hardyi* males which reach a maximum snout-vent length of about 351 mm and females which reach a total of 367 mm. *Tropidophis pardalis* regularly has 6 longitudinal rows of blotches, whereas *T. n. hardyi* may have 8 but modally 6 rows of blotches. Both *T. pardalis* and *T. n. hardyi* often have 2/2 postoculars. The smaller head of *T. n. hardyi* also tends to distinguish these two taxa. We can do no better than to reiterate our previous comments: we feel certain *T. n. hardyi* is a distinct entity, but whether we correctly associate it with *T. nigriventris* or whether it is indeed a peculiarly local and circumscribed population of *T. pardalis* remains to be determined. So much of central and western Cuba remains unknown as far as these small multispotted boas are concerned that speculation on their relationships is indeed futile.

Finally, comparisons of *T. p. galacelidus* and *T. pardalis* are easily made. The former has a pair of pale occipital spots, whereas the latter

rarely does; and, if present, the spots are much smaller, less contrasting, and less conspicuous than in *T. p. galacelidus*. *Tropidophis p. galacelidus* has 10 rows of small blotches (6 rows of large blotches in *T. pardalis*), a greater number of ventral scales (177–183 versus 136–155 in *T. pardalis*), and (at least females) reaches a much larger size (374 mm) than *T. pardalis* (303 mm). If *T. pardalis* and *T. p. galacelidus* occur syntopically, they should be easily distinguishable on the basis of the above characters.

*Specimens of T. n. nigriventris examined*: Cuba, Camagüey Province, 6 mi. (about 9.6 km) E Martí (UMMZ 70889–holotype; UMMZ 70887); Finca El Porvenir, 24 km SW Camagüey, Loma de Yagua (AMNH 81182–83).

## Literature Cited

Bailey, J. R. 1937. A review of some recent Tropidophis material. Proc. New England Zool. Club 16:41–52.

Dowling, H. G. 1951. A proposed standard system of counting ventrals in snakes. Brit. J. Herpetology 1(5):97–99.

Schwartz, A., and R. J. Marsh. 1960. A review of the *pardalis-maculatus* complex of the boid genus *Tropidophis* in the West Indies. Bull. Mus. Comp. Zool. 123(2):49–84, 10 figs.

QH
1
B4X
NH

10, pp. 91–94 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# DATES OF PUBLICATION OF WESTWOOD'S ARCANA ENTOMOLOGICA

By J. Chester Bradley[1]
*Comstock Hall, Cornell University, Ithaca, N.Y. 14850*

John Obadiah Westwood published Arcana entomologica; or illustrations of new, rare, and interesting insects, in London in two volumes, the title page of each of which bore the date MDCCCLV. Each volume was a republication of pages or groups of pages which had originally been independently published on the precise date printed at the foot of the page, or at the foot of the first page of a group of pages, and were being republished without any change in these originally indicated dates of publication.

Dealing with a world-wide fauna, a great many new taxa, now well known, were described or commented upon in the Arcana. Some cataloguers and authors referring to the taxa included in it ascribed to them the date of the republished volume, i.e. December 31, 1845. That is false. Each dates from when the part in which it appeared was actually published. This will change the publication date of a great many taxa from that which is ordinarily accorded them.

In the analysis that follows the pagination of each part and its date of publication is given, so that anyone knowing the page on which a taxon was described can instantly discover its actual date. For example, in Kirby's Catalogue of the Orthoptera, *Phylocrania insignis* is dated from 1845, the date of the volume in which it was republished. It was actually published in Part E2 on November 1, 1843.

The purpose of this paper is to make it easy for any biologist to discover the correct date of publication of every taxon included in the Arcana.

[1] Deceased.

These changes in the dates accorded to Westwood's taxa in many catalogues are not capricious but are compelled by the International Code of Zoological Nomenclature.

The style of the Arcana is complicated, but after the frontispiece of volume one, Westwood has applied it consistently through both volumes without so much as a single variation. The arrangement may be comprehended from an examination of the following excerpts:

"No. 8.—1st July, 1842
(I 113–114, pls. 29,30)(I2 115–128, pls. 31,32)
No. 9.—1st September, 1842
(K 129–130, pls. 33,34,35,36)(K2 131–144, pls. 37,38, 39,40)"

The division of each lettered section into two parts, such as K and K2, is maintained throughout the entire work.

The numbered sections were issued bimonthly, each published on the first day of the month.

### The Date of Publication of the Numbered Sections of the Arcana Volume 1, 1845

Pl. 15 (Frontispiece)

1st January, 1842
(B 1–2, pl. 1)(B2 3–16, pls. 2,3,4)
(C 17–18, pl. 5)(C2 19–32, pls. 6,7,8)
(D 33–34, pl. 9)(D2 35–48, pls. 10,11,12)
(E 49–50, pls. 13,14)(E2 51–64, pls. 15,16)
No. 5.—1st January, 1842
(F 65–66, pl. 17)(F2 67–80, pls. 18,19,20)
No. 6.—1st March, 1842
(G 81–82, pls. 21,22,23)(G2 83–96, pl. 24)
No. 7.—1st May, 1842
(H 97–98, pl. 25 Frontispiece)(H2 99–112, pls. 26,27,28)
No. 8.—1st July, 1842
(I 113–114, pls. 29,30)(I2 115–128, pls. 31,32)
No. 9.—1st September, 1842
(K 129–130, pls. 33,34,35,36)(K2 131–144, pls. 37,38,39,40)

No. 10.—1st November, 1842
(L 145–146)(L2 147–160)
No. 11.—1st January, 1843
(M 161–162, pl. 41)(M2 163–176, pls. 42,43,44)
No. 12.—1st March, 1843
(N 177–178, pls. 45,46)(N2 179–190, pls. 47,48)

VOLUME 2, 1845

No. 13.—1st May, 1843
(B 1–2, pls. 49,50)(B2 3–16, pls. 51,52)
No. 14.—1st July, 1843
(C 17–18, pls. 53,54)(C2 19–32, pls. 55,56)
No. 15.—1st September, 1843
(D 33–34, pl. 57)(D2 35–48, pls. 57,58,59,60)
No. 16.—1st November, 1843
(E 49–50, pl. 61)(E2 51–64, pls. 62,63,64)
No. 17.—1st January, 1844
(F 65–66, pl. 65)(F2 67–80, pls. 66,67,68)
No. 18.—1st March, 1844
(G 81–82, pl. 68)(G2 83–96, pls. 69,70,71)
No. 19.—1st May, 1844
(H 97–98, pl. 72)(H2 99–112, pls. 73,74,75)
No. 20.—1st July, 1844
(I 113–114, pls. 76,77)(I2 115–128, pls. 78,79)
No. 21.—1st September, 1844
(K 129–130, pl. 80)(K2 131–144, pls. 81,82,83)
No. 22.—1st November, 1844
(L 145–146)(L2 147–160, pls. 84,85,86,87)
No. 23.—1st February, 1845
(M 161–162, pls. 88–95)(M2 163–176)
No. 24.—1st June, 1845
(N 177–178)(N2 179–191)

On page 191 the "Addenda et Corrigenda" apply to both volumes and include some corrections in synonymy. There are also "Errata" preceding page 1 in Volume One.

The Arcana is a work of great rarity. In some libraries the work is kept under lock and key.

QH
1
B4X
NH

No. 11, pp. 95–112 23 April 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# THE SPECIES OF *TAMANDUA* GRAY (EDENTATA, MYRMECOPHAGIDAE)

By Ralph M. Wetzel
*Biological Sciences Group, University of Connecticut*
*Storrs, Connecticut 06268*

Over an extensive range from southern México to northern Argentina and Uruguay, the anteaters of the genus *Tamandua* display great variation in colors of coats and in proportions of skulls. Central American populations are black-vested, but in South America the pelage varies from a monochromatic black, brown, tan or white through a gradient of bichromatic patterns to a black-vested condition. After a taxonomic history in which writers gave not less than ten specific names to the tamanduas, treatment of the genus during this century has been chiefly either (1) as containing two species—*T. tetradactyla* L. for the black-vested forms and *T. longicaudata* (Wagner) for those lacking a complete vest, or (2) as monotypic, the species *T. tetradactyla* containing different subspecies of which one was the nonvested or partially vested *T. t. longicaudata.* One melanistic form, *nigra* Geoffroy, has been assigned to either of the two species, while a second melanistic form, *quichua* Thomas, has been more uniformly retained as a subspecies of *T. tetradactyla.*

This study was initially concerned with the identification of the extensive series of *Tamandua* collected by the Smithsonian Venezuelan Project under the direction of Dr. Charles O. Handley, Jr. The black-vested tamanduas of northwestern Venezuela proved to be distinctly separable from the geographically adjoining samples of nonvested forms from a variety of habitats. In turn, the nonvested forms were bound through a clinal chain to black-vested forms south of Venezuela.

Correlating these two differences—a disjunction line in northwestern Venezuela and a cline to the south—with taxonomic levels required samples from areas well beyond the original focus of the study. To this end, I examined specimens which were available in other collections from throughout the range of the genus.

## Procedures

*Color and Color Patterns*: I recorded patterns of pelage (Fig. 1) as:

A) Vested. A vivid black area on the trunk, continuous from black shoulder stripes posteriorly to the rump and widening behind the shoulders to encircle the body. This vest is surrounded by a uniformly pale color of white, tan or gold on the rest of the body, the legs, and the heavily furred base of the tail. The pale color also divides the vest as a middorsal stripe from the neck to the middle or posterior portions of the back. Such pelage is found in all specimens from the northwestern portion of the range of the genus (AMNH 17272, México, Vera Cruz, Pasa Nueva; USNM 443242, Venezuela, Zulia, El Rosario) and from the lower Amazon basin south to Uruguay (NRMS 508, Brazil, Pará, Cametá; Uruguay, Cerro Largo, Estancia La Formosa, see Ximénez, 1972: plate).

B) Nonvested. Specimens have completely uniform pelage, light tan, buffy white, or gold in color, with no obvious indication of vest pattern (USNM 441973, Venezuela, Falcón, Capatárida; ROM 31883, Guyana, Rupununi, Dadanawa Ranch). In some specimens (USNM 441971, Venezuela, Capatárida) a vague vest pattern could be seen only by parting the hairs, as the bases of hairs were slightly darker than the tips.

C) Partially Vested. Obvious appearances of the vest first occur usually in the shoulder area as smudges or even vivid stripes, though the rest of the body is uniformly pale (ANSP 4635, probably Chapada, Mato Grosso, Brazil, holotype of *M. bivitatta straminea* Cope). At the darker end of the gradient, the vest appears grizzled or gray because of dark hairs with tan tips; black shoulder stripes usually accompany this coloration (FMNH 25261, Bolivia, Santa Cruz; USNM 361029, Guyana, Dadanawa Ranch). In searching for correlations of variation in pelage with cranial and external measurements and proportions, I rated the gradient from completely pale and uniform pelage to the nearly complete pattern of the vest as stages of one to nine.

D) Melanistic. Specimens in this category have overall, completely black (BMNH 27.1.1.156, Perú, San Martín, Yurac Yacu, holotype of *M. t. quichua* Thomas) or dark brown pelage. Variants, not recorded as melanistic, are individuals with pale foreheads and legs but with uniformly dark brown pelage from ears to rump. This color form, as well as those with uniformly dark brown pelage, strongly suggests a gradient from complete melanism to the partially vested condition.

*Variation in Pelage by Age, Sex, and Season*: I found no major

FIG. 1. Localities of *Tamandua* specimens examined. Three peripheral records from the literature are added: I, Dalquest, 1953; II, Carvalho, 1962; III, Ximénez, 1972.

changes in pelage between immaturity and adulthood; but specimens of young tamanduas have longer dorsal hair, in proportion to size of the body, which gives them a fluffy appearance. In addition, the immature vested specimens tend to have a greater proportion of pale hairs visible in the vest areas. Aside from this I found no basis for statements by Azara (1801:107) and Liais (1872:360) that color variation is correlated with age. No pronounced sexual difference in pelage was found except that in localities presenting a gradient of partially vested forms, the darker specimens are usually males (USNM 406686, female, Capibara vs. USNM 406688, male, San Juan de Río Manapiare, both from Territorio Amazonas, Venezuela). One sample (Guyana, Dadanawa Ranch, in USNM and ROM) is large enough to demonstrate that there is little or no seasonal variation in pelage. However, more data are needed on this point and on rates of growth of hair and hair replacement.

*Cranial Characters*: Each skull was assigned to one of five arbitrary age classes on the basis of sequence of closure of sutures. Measurements of skulls in age classes 0 and 1 (no closures except for sutures of the occipital in class 1) were not included in geographical comparisons because of the magnitude of differences in proportions and measurements, particularly shorter and narrower rostra. Age class 1 was considered a stage of transition to sexual maturity as the Smithsonian Venezuelan Project collected a few females of this age with embryos. Comparison of adult males and females (age classes 2–5) from similar geographical areas revealed no significant sexual differences in cranial measurements or proportions.

The following cranial dimensions and their abbreviations are included in this paper (Fig. 2):

ARW—anterior rostral width; taken with the anterior flat face of the calipers at the level of the most posterior lateral indentation of the anterior part of the maxilla.

FMW—maximal width of foramen magnum.

IFL—infraorbital foramina, mean of minimal lengths of pair.

NL-a, NL-b—nasal bones: a, minimal length at midline and b, maximal length.

OL—occipito-nasal length, distance from maximal posterior extension of occipital, dorsal to the formen magnum, to anterior tip of nasal bone.

RL—rostral length, derived as in the altitude of a triangle where the distance between the lacrimal foramen to the anterior tip of the nasal bone (probably the RL of Reeve, 1942 and Davis, 1955) is considered the hypotenuse and half the antorbital width is considered the base.

PRL—post-rostral length, derived as the difference between OL and RL.

AOB—antorbital breadth, minimal width of skull at the level of the lacrimal foramina.

ORB—interorbital breadth, minimal width between the middorsal borders of the orbits.

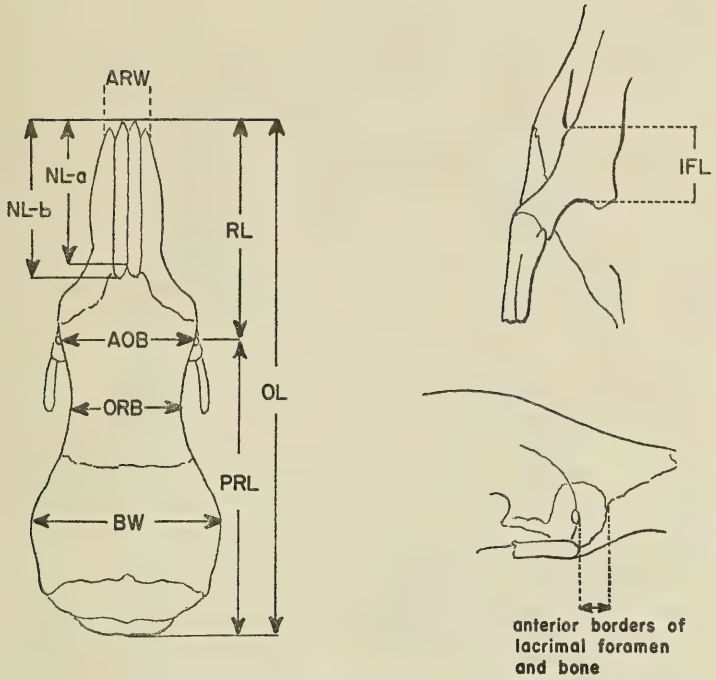



FIG. 2. Illustration of measurements of skulls of *Tamandua.*

BW—breadth of braincase, maximal breadth of skull posterior to zygomatic processes.

Two cranial characters that were scored, rather than measured, proved to have taxonomic value (Fig. 3):

1) The presence of four pairs of foramina (optic, orbital fissure, foramen rotundum, foramen ovale) in the orbit or only three pairs. The latter condition is caused by the absence of a bony septum between the orbital fissure (= anterior lacerate foramen) and the foramen rotundum. Bilateral asymmetry in some of the specimens required an averaging of this condition between left and right sides as well as partial scoring for incomplete septa. Since these septa are incompletely ossified in the youngest specimens, as well as more easily destroyed in the cleaning of immature skulls, no count of septa for immature specimens is included in the geographical comparisons.

2) The shape of the posterior (palatal) border of the infraorbital foramen. The maxilla either (a) extends as far, or farther, posteriorly on the medial side of the foramen as it does on the lateral side, resulting

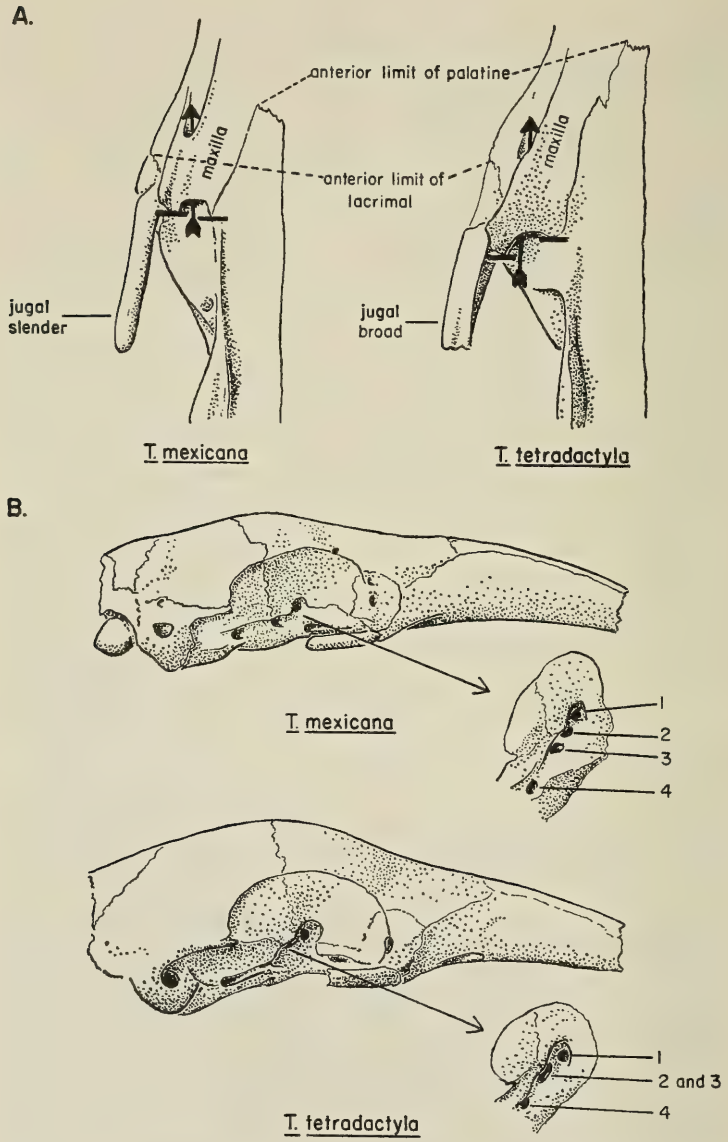



FIG. 3. Comparison of selected cranial characters in *Tamandua. T. mexicana*, CONN 16875, Chepo, Panamá; *T. tetradactyla*, CONN 16831, Km 285, Trans-Chaco highway, Paraguay. Both are black-vested specimens.

in a crescent-shaped border of the foramen, or (b) terminates on the medial side of the foramen distinctly anteriorly to the lateral side, resulting in a subequal or incomplete crescent-shaped border of the foramen.

When compared with the distances between the anterior border of the lacrimal foramen and bone (Fig. 2), the distances between the anterior borders of the palatine and lacrimal bones (parallel to the long axis of the skull, Fig. 3) are proportionally different between the two species.

*Count of Vertebral Regions*: A total of 39 vertebral columns was examined, but only individual vertebral regions that were without missing vertebrae are included in the diagnoses of the species. My count of the sacral region began with the first vertebra completely articulating with the ilia and ended with the last vertebra completely articulating with the ischia.

*Sources of Specimens*: Although tamanduas from over 40 collections have been examined, only the following collections and their curators at the time of study are cited here: AMNH—American Museum of Natural History, New York; Richard G. Van Gelder. ANSP—Academy of Natural Sciences of Philadelphia, Philadelphia; H. Radcliffe Roberts. BMNH—British Museum (Natural History), London; G. B. Corbet. CONN—University of Connecticut Museum of Natural History, Storrs; Robert E. Dubos. FMNH—Field Museum of Natural History, Chicago; Joseph Curtis Moore. MCZ—Museum of Comparative Zoology, Harvard University, Cambridge; Barbara Lawrence. MNHN—Muséum National d'Histoire Naturelle, Paris; F. de Beaufort and Jean Dorst. MZUV—Musée Zoologique de l'Université et de la Ville, Strasbourg; F. Gouin and Jean-Pierre Rieb. NRMS—Naturhistoriska Riksmuseet, Stockholm; Ulf Bergström (deceased) and Greta Vestergren. PARA—Museu Paraense "Emílio Goeldi," Belém; Fernando C. Novaes. ROM—Royal Ontario Museum, Toronto; Randolph L. Peterson. SMF—Natur-Museum und Forschungsinstitut Senckenberg, Frankfurt am Main; Heinz Felten. TCWC—Texas Cooperative Wildlife Collection, Texas A & M University, College Station; Dilford C. Carter. USNM—National Museum of Natural History, Smithsonian Institution, Washington, D.C.; Charles O.

---

←

A. Views of right palate. Infraorbital foramen is marked by an arrow and the medial and lateral margins of the posterior opening, by bars. Compare: posterior limits of maxilla on either side of foramen, anterior limits of the palatine and lacrimal bones, and dimensions of jugal bone.

B. Right side of skulls and detailed view of orbits, tilted to show foramina. 1, optic foramen; 2, orbital fissure; 3, foramen rotundum; 4, foramen ovale. Foramina 2 and 3 are separate in *T. mexicana* but combined in *T. tetradactyla* or separated by a deeply set, slender septum which is visible from lateral view only at its base.

Handley, Jr. ZSM—Zoologische Sammlung des Bayerischen Staates, Munich; Theodor Haltenorth.

## Genus *Tamandua* Gray

*Tamandua* Gray, 1825:343.
*Tamanduas* F. Cuvier, 1829:501.
*Uroleptes* Wagler, 1830:36; Palmer, 1899:73.
*Dryoryx* Gloger, [1841]:112.

The black-vested populations of *Tamandua* are separated by 2,000–3,000 kilometers (1,200–2,000 miles) containing the intervening nonvested, partially vested, and melanistic forms (Fig. 1). The vested group occupying the northwestern part of the range of the genus (México to northwestern Venezuela) has been traditionally placed in the same species, *T. tetradactyla*, with the vested group in the southeastern portion of the generic range (Amazon basin to southeastern Brazil and northern Argentina). The few comparisons that have been made over much of the range of the genus, such as Allen (1904), Krumbiegel (1940), and Reeve (1942), have assumed a specific relationship of these two vested populations. Krumbiegel and Reeve, as well as Schröder (1937), then considered the question of the uniqueness of the nonvested and partially vested forms. Upon finding these *T. longicaudata* clinally integrating with *T. tetradactyla* in Brazil, and lacking specimens for adequate comparison of the two forms at their juncture in Venezuela, these writers concluded that *Tamandua* was a monotypic genus.

Because of the new material collected by the Smithsonian Venezuelan Project, as well as the opportunity to study many other specimens not seen by the previous authors, I could compare *longicaudata* at all of its boundaries with the vested tamanduas. Geographical gradients in both pelage and skulls were found between the southern populations of vested tamanduas and the *longicaudata* pelage forms. This was particularly evident in the Amazon basin where a gradual cline occurred from nonvested and partially vested *longicaudata* in eastern Ecuador, Perú, and western and central Brazil to vested *tetradactyla* in eastern Amazonas to eastern Pará, Brazil. A south-to-north gradient was found between the vested forms from the left or north bank of the Rio Amazonas to *longicaudata* of the Guyana highlands. To the north, the Río Orinoco proved to be only a partial barrier for *longicaudata.*

The second question was the taxonomic level of distinction between the black-vested tamanduas west of the Andes and those lacking complete vests and occurring immediately east of the Andes. This question involved comparing specimens from (a) either side of the Andes in Ecuador, (b) the Río Magdalena valley with those from the eastern side of the Cordillera Oriental in Colombia, and (c) northwestern Venezuela and Colombia with those from adjacent Venezuela and Colombia east of the Cordillera Oriental. All of these comparisons indicated

TABLE 1. Comparison of the species of *Tamandua*.

| *mexicana* | *tetradactyla* |
|---|---|
| Black vest always present | Color of pelage geographically variable; black vest always present only in portions of range most distant from *T. mexicana* |
| Ear shorter (means 40–46 mm) | Ear longer (means 50–54 nearest to range of *T. mexicana*) |
| Skull slender (means of AOB, ORB, and BW less than 34, 25, and 42 mm) | Skull broad (means of AOB, ORB, and BW greater than 34.5, 25, and 41.5) |
| 4 pairs of orbital foramina in most skulls | 3 pairs of orbital foramina in most skulls |
| Posterior border of infraorbital foramen distinctly crescent shaped | Posterior border of infraorbital foramen an incomplete crescent; maxilla forming subequal borders about foramen |
| Jugal bone slender (height usually no more than 31% of length) | Jugal bone broad (height more than 31% of length) |
| Distance between anterior borders of palatine and lacrimal bones proportionally less | Distance between anterior borders of palatine and lacrimal bones proportionally greater |
| Caudal vertebrae 40–42 | Caudal vertebrae 31–39 |

major lines of interruption coinciding with the Andean chain. This separation within the genus is abrupt, certainly not clinal as are the variations that extend from this point to the peripheries of the range, and is of such a major nature as to require consideration of two species: (1) a black-vested species, *T. mexicana*, occurring west of the eastern Andean divide from northwestern Venezuela and the Pacific slope of northern Perú to México, and (2) a black-vested to nonvested species confined to South America east of the Andes and including the nominate form, *T. tetradactyla*, as well as geographical color variants such as *longicaudata*, *quichua*, and *nigra*. The comparison of these two species is presented in Table 1. All measurements are in millimeters. The lists of synonyms, although incomplete, include most of the original names and new combinations, the names used in the more comprehensive studies of the genus, and the names used by the standard references for the two continents (Cabrera, 1958; and Hall and Kelson, 1959). Holotypes and certain other critical specimens that I have examined are cited.

*Tamandua mexicana* (Saussure)

*Myrmecophaga tamandua* (?), Desm. (var. *Mexicana*, Sauss.) Saussure, 1860:9.

*Tamandua tetradactyla*.—Tomes, 1861:287; Sclater, 1871:546.

*Myrmecophaga tetradactyla*.—Frantzius, 1869:307.

*Tamandua bivittata* Var. 3. *Opistholeuca* Gray, 1873a:27, only the specimens from Central America and Colombia. Lectotype (herewith selected): BMNH 50.7.8.39, skin and skull, "Colombia," coll. Parzudaki; labeled as "type"; listed by Gray as the second syntype.

? *Tamandua tetradactyla*, var. *leucopygia* Gray, 1873b:469. Colombia, Antioquia, Concordia or Medellín. Nomen nudum; although BMNH 73.4.23.8, same locality, coll. J. K. Salmon, was probably the basis for this name, Gray did not support his name with description, reference, or indication.

? *Myrmecophaga quadridactyla* True, 1884:588, in part. Nomen nudum.

*Myrmecophaga sellata* Cope, 1889:133. Type-locality: Honduras.

*Tamandua tetradactyla instabilis* Allen, 1904:392; Krumbiegel, 1940:174; Reeve, 1942:300; Cabrera, 1958:204. Holotype: AMNH 23420, Colombia, Magdalena, Bonda.

*Tamandua tetradactyla tenuirostris* Allen, 1904:394. Holotype: AMNH 17272, México, Vera Cruz, Pasa Nueva.

*Tamandua tetradactyla chiriquensis* Allen, 1904:395; Krumbiegel, 1940: 172; Hall and Kelson, 1959:238. Holotype: AMNH 18883, Panamá, Chiriquí, Boquerón.

*Tamandua tetradactyla mexicana*.—Allen, 1906:200; Reeve, 1942:300; Hall and Kelson, 1959:239.

*Tamandua tetradactyla punensis* Allen, 1916:83; Cabrera, 1958:204. Holotype: AMNH 36452, Ecuador, Isla Puná.

*Tamandua tetradactyla sellata*.—Goldman, 1920:63, footnote; Lönnberg, 1937:27; Krumbiegel, 1940:172.

*Tamandua tetradactyla tambensis* Lönnberg, 1937:25. Holotype: NRMS 18, Colombia, Cauca, El Tambo.

*Tamandua tetradactyla tetradactyla*.—Reeve, 1942:300, in part in which *T. t. chiriquensis*, *tambensis*, and *punensis* are considered as probable synonyms of subspecies *tetradactyla*.

*Tamandua tetradactyla hesperia* Davis, 1955:558; Hall and Kelson, 1959: 238. Holotype: TCWC 5322, México, Guerrero, near Acahuizotla.

*Type-locality*: México, Tabasco (Saussure, 1860:9).

*Range*: From the lower forested slopes of the southern edge of the Mexican plateau, in southeastern San Luis Potosí, Guerrero, and northwestern Oaxaca, through Central America to northwestern Venezuela, the valleys and montane forests of Colombia west of the divide of the Cordillera Oriental, and south in the forested coastal and Pacific Andean slopes of Colombia, Ecuador, and northwestern Perú (Fig. 1).

*Diagnosis*: *Pelage*—always black-vested on a paler background, rather

than uniformly black, brown or tan. *Ear*—range of means of length from notch, 40–46. *Skull*—slender, with means of AOB, ORB and BW for all samples falling below 34, 25 and 42, respectively, except for a gradient to larger skulls in the upper valleys of Río Cauca and Río Magdalena in Colombia; four orbital foramina (Fig. 3B) present in at least one side of all skulls from southeastern part of range of species and present in both sides of skulls of 80–100% of all specimens except for those from Guerrero, México (70%), and coastal Ecuador (60%); posterior (palatal aspect) border of infraorbital foramen (Fig. 3A) distinctly crescent-shaped and formed entirely by maxilla, with medial border of foramen extending as far posteriorly as (or farther than) lateral border; distance (measured perpendicular to midline of skull) between most anterior extension of palatine and lacrimal bones (Fig. 3A) less than half the distance between anterior borders of lacrimal foramen and lacrimal bone (Fig. 2); jugal (malar) slender (Fig. 3A), its greatest height usually 31% or less of its greatest length. *Vertebral count*—14 specimens from México (1, FMNH), Guatemala (3, USNM), Honduras (1, FMNH), Panamá (1, CONN), and northeastern Colombia (7, AMNH; 1, USNM): cervical 7 (in 10); thoracic 17.0 (15–18, in 11); lumbar 2.4 (2–3, in 14); sacral 5 (in 14); caudal 40.8 (40–42, in 8).

*Comparison*: See Table 1.

### *Tamandua tetradactyla* (Linné)

*Myrmecophaga tetradactyla* Linné, 1758:35.

*Myrmecophaga myosura* Pallas, 1766:64. Type-locality: Brazil.

*Myrmecophaga tamandua* G. Cuvier, 1798:143. No locality; pelage described as "jaunatre."

*Myrmecophaga nigra* Geoffroy St.-Hilaire, 1803:217. "La Guyane?" In part: Azara, 1809:plate 7; Desmarest, 1817:107.

*Myrmecophaga tamandua* Geoffroy St.-Hilaire, 1803:217, in part [based upon both *M. tridactyla* L. and *T. tetradactyla* (L.)]. No locality.

*Myrmecophaga bivittata* Desmarest, 1817:107. Brazil.

*Uroleptes tetradactyla*.—Wagler, 1830:36.

*Myrmecophaga tridactyla* (not Linné, 1758:35).—McMurtrie, 1831:166, as synonym of *M. tamandua* Cuv.

*Tamandua crispa* Rüppell, 1842:179. "Guiana." Holotype not listed in Mertens, 1925, nor found in SMF in 1970.

*Tamandua tetradactyla*.—Gray, 1843:191. Brazil.

*Myrmecophaga longicaudata* Wagner, 1844:211. Type-locality restricted to Surinam by Cabrera, 1958:203.

? *Myrmecophaga longicaudata* Turner, 1851:218. No locality or reference, nomen nudum.

*Uroleptes bivittatus*.—Fitzinger, 1860:395. Brazil.

*Tamandua bivittata*.—Gray, 1865:384. Brazil, Paraguay.

*Tamandua ursina*.—Gray, 1865:384, as synonym for *T. bivittata*.

*Tamandua longicaudata.*—Gray, 1865:384; Allen, 1904:385.
*Tamandua brasiliensis* Liais, 1872:360. Brazil.
*Tamandua bivattata.* Var. 1. *Opisthomelas* Gray, 1873a:27. Lectotype (herewith selected): BMNH 40a, skin, Brazil, coll. Lt. Mawe; labeled as type; first in Gray's list of syntypes.
? *Myrmecophaga quadridactyla* True, 1884:588, in part. Nomen nudum.
*Tamandua tamandua.*—Jentink, 1888:215. Surinam.
*Myrmecophaga bivattata straminea* Cope, 1889:132. Holotype: ANSP 4635, skin, Brazil, probably Mato Grosso, São João or Chapada.
*Tamandua tetradactyla nigra.*—Menegaux, 1902:494. French Guiana, Cayenne, Ouanary River (MNHN 1902–62, melanistic skin).
*Tamandua tetradactyla tetradactyla.*—Allen, 1904, by implication; Schröder, 1937:135; Krumbiegel, 1940:175, in part; Reeve, 1942:300, in part; Cabrera, 1958:205, in part.
*Tamandua tetradactyla chapadensis* Allen, 1904:392; Krumbiegel, 1940: 174; Reeve, 1942:300; Cabrera, 1958:203. Holotype: AMNH 369, Brazil, Mato Grosso, Chapada.
*Tamandua longicaudata longicaudata.*—Beaux, 1908, by implication; Cabrera, 1958:203.
*Tamandua longicaudata nigra.*—Beaux, 1908:417. "Brasilien (?)."
*Tamandua tetradactyla quichua* Thomas, 1927:371; Reeve, 1942:300; Cabrera, 1958:205. Holotype: BMNH 27.1.1.156, Perú, San Martín, Yurac Yacu.
*Tamandua tetradactyla longicaudata.*—Pittier and Tate, 1932:255; Schröder, 1937:136; Krumbiegel, 1940:175; Reeve, 1942:300.
*Tamandua tetradactyla kriegi* Krumbiegel, 1940:171. Holotype: ZSM 1931-284, Paraguay, Estancia Zanja Moroti.
*Tamandua tetradactyla straminea.*—Krumbiegel, 1940:174.
? *Tamandua longicaudata mexianae.*—Cabrera, 1958:203. Type-locality: Brazil, Pará, Ilha Mexiana. Nomen nudum, not in Hagmann, 1908:29, as cited by Cabrera; no specimens from Ilha Mexiana found at PARA, MZUV, or elsewhere.

*Type-locality*: Brazil, Pernambuco (Thomas, 1911:133).

*Range*: South America east of the Andes, from Venezuela and Trinidad south to the state of Rio Grande do Sul in Brazil, the department of Cerro Largo in Uruguay (Ximénez, 1972), and the provinces of Santa Fe, Chaco, Salta, and Jujuy in Argentina.

*Diagnosis*: *Pelage*—color geographically variable, black vest always present only in specimens from southeastern portion of range (Fig. 1), gradating to partially vested or nonvested blond, tan or brown individuals elsewhere in range; melanistic forms from eastern foothills of Andes in Perú and Ecuador east along Amazon River to Amapá and coastal French Guiana. *Ear*—range of means of length from notch, 50–54 in all samples except 43–48 in southeastern portion of range. *Skull*—broad, with means of AOB, ORB and BW greater than 34.5, 25 and 41.5, respectively, except in samples from portions of Amazon basin and thorn forests of

northwestern Venezuela; only three orbital foramina present in at least one side of all skulls from a northwestern portion of range and in both sides of 80–100% of the skulls from eastern edge of Andes, decreasing to 60% in Amazon basin and 50% in southeastern Brazil (Fig. 3B); posterior (palatal aspect) border of infraorbital foramen an incomplete crescent, its medial border not extending as far posteriorly as its lateral border, and medial border formed either entirely by palatine or by a combination of maxilla and palatine (Fig. 3A); distance (measured perpendicular to midline of skull) between anterior borders of palatine and lacrimal bones (Fig. 3A) at least one-half distance between anterior borders of lacrimal foramen and lacrimal bone (Fig. 2); jugal relatively wide, its greatest height 31% or more of its greatest length (Fig. 3A). *Vertebral count*—25 specimens from Guyana (2, AMNH); lower Amazon basin (1, AMNH), Minas Gerais (1, MCZ), and Mato Grosso (1, USNM), Brazil; northeastern Bolivia (10, AMNH); the Chaco of Paraguay (10, CONN): cervical 7 (in 19); thoracic 17.3 (16–18, in 22); lumbar 2.5 (2–3, in 25); sacral 5 (in 25); caudal 34.5 (31–39, in 19).

*Comparison*: See Table 1.

*Comments*: Except as noted above, the extensive geographical variation within the genus prohibits a satisfactory delineation of the two species based only on external measurements and size and proportions of skulls. Both species contain large and small subspecies, clinally arranged, some undescribed and others with geographical limits incorrectly defined in the literature. The geographical span of samples compared by Reeve (1942) embraced, in the main, too wide a spectrum of subspecific variation to be useful in resolving the question of specific separation. However, my comparison of smaller geographical units, made possible by larger samples available, permits the separation of any one subspecies of *T. mexicana* from any one of *T. tetradactyla.* This is particularly striking where the geographic ranges of the two species are contiguous in northwestern Venezuela. There all measurements of body and skull, as well as pelage color and the discrete skull characters of Fig. 3, are significantly different between the two species. The features of pelage color, discrete skull characters, and certain measurements and proportions also show pronounced character displacement; examples of this displacement are shown in Fig. 4.

The isolation leading to separation into the present two species on either side of the Andes has been relatively complete as compared to events occurring in South America east of the Andes. Even so, my data indicate two centers of isolation and later dispersal there, one in the highlands of Brazil and the other in the Guyana highlands and eastern foothills of the Andes. Along the boundary between the two centers, marked roughly by the Amazon and its western tributaries, occur the greatest variation in color of pelage and a clinal decrease in size of specimens. For example, melanistic specimens have been collected from coastal French Guiana and the state of Amapá, Brazil, west through the immediate Amazon basin to the eastern foothills of Ecuador and Perú.

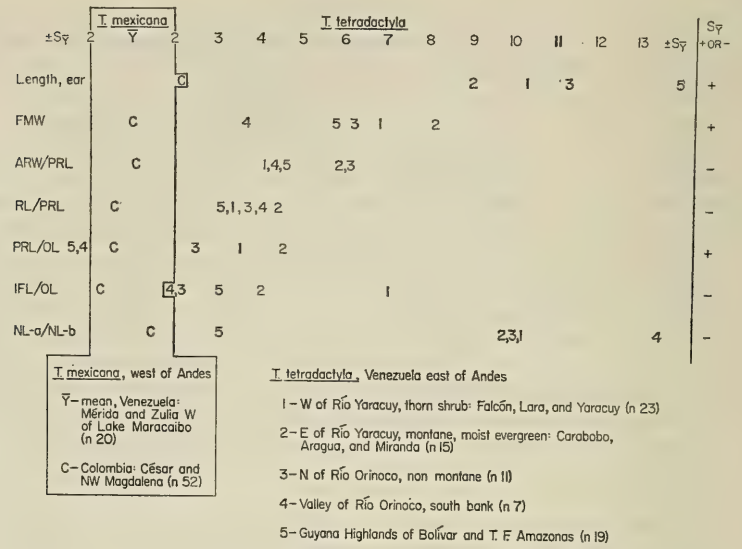



FIG. 4. Ratio diagram for measurements of *Tamandua* from juncture of the two species in northern South America. $S_{\bar{Y}}$ is estimate of standard error of mean. Samples of *T. tetradactyla* are numbered 1–5 in increasing order of geographical distance from nearest population of *T. mexicana*. See text (pages 98–99) for definitions of abbreviations used for cranial measurements.

This distribution coincides with the areas of major variation between nonvested and vested forms. The inclusion of a figure entitled "Le Tamandua noir, variété du Tamandua ordinaire" in Azara (1809:plate 7) must be disregarded as evidence that melanistic tamanduas have been found in Paraguay. Azara (1801 and 1809) made no textual reference to melanistic tamanduas. The plate in question is a composite of a giant anteater, *Myrmecophaga tridactyla* L., and a black *Tamandua tetradactyla* (L.). The lateral head stripe and contours of the head, ears, and apparently the 1st and 2nd claws (despite depicting digits 1, 2 and 4 as medial to the longest claw on digit 3) are those of *Myrmecophaga tridactyla*, while the remaining body, legs, and tail are those of *Tamandua*. The textual description (Azara, 1809:255) cited for this plate is for *M. tridactyla*. Desmarest (1817:107) referred this figure to the black tamandua, *M. nigra* (presumedly that of Geoffroy St.-Hilaire, 1803:217, which in turn is based upon MNHN 431 from "La Guyane?") without reference to geographical origin. I have found no melanistic specimens from Paraguay, Mato Grosso or Bolivia, an area containing both vested tamanduas and those having only black shoulder stripes.

The melanistic tamanduas are, perhaps, examples of the saturate stage before progressive subtraction of melanin to paler, more uniformly colored indivuals as discussed by Hershkovitz (1968). This may have been triggered by cross-mating between populations formerly isolated in late Pleistocene along the Andean foothills and the Guyana highlands with those from the highlands of Brazil (see Vanzolini, 1973). An alternate explanation of the distribution of melanistic forms could begin with a population having a high incidence of melanism that spread from the foothills of the Andes easterly along the Amazon drainage to the Atlantic coast. This does not explain the evidence of clinal variation in size, the highly variable pelage, and differences in orbital foramina as does the concept of two dispersal centers.

Acknowledgments

I am grateful to the curators of the collections cited for allowing me to examine specimens in their care. Additional appreciation is due Dr. Charles O. Handley, Jr., National Museum of Natural History, for his support and encouragement of this study and for critically reading the manuscript. I also thank my wife, Drew, who assisted in many ways, Mary Hubbard who prepared the illustrations, and D. Wilcox who read the manuscript. This paper is a contribution of the Smithsonian Venezuelan Project, supported by a contract (DA–49–193–MD–2788) of the Medical Research and Development Command, Office of the Surgeon General, United States Army. Travel funds from the University of Connecticut Research Foundation, the National Geographic Society, and the American Philosophical Society also aided this study.

Literature Cited

Allen, J. A. 1904. The tamandua anteaters. Bull. Amer. Mus. Nat. Hist. 20:385–398.

———. 1906. The proper name of the Mexican tamandua. Proc. Biol. Soc. Wash. 19:200.

———. 1916. New South American mammals. Bull. Amer. Mus. Nat. Hist. 35:83–87.

Azara, F. de. 1801. Essais sur l'histoire naturelle des quadrupèdes de la province du Paraguay. Vol. 1. Paris.

———. 1809. Voyages dans l'Amérique méridionale. Collection de planches, pl. 7. Paris.

Beaux, O. de. 1908. Über die schwarze Varietät der Tamandua longicaudata Gray. Zool. Anz. 33:417–418.

Cabrera, A. 1958. Catálogo de los mamíferos de America del Sur. I. Rev. Mus. Argentino Cienc. Nat. "Bernardino Rivadavia," 1957, Zool. 4(1):1–307.

Carvalho, C. T. 1962. Lista preliminar dos mamíferos do Amapá. Papéis Avulsos Dept. Zool., S. Paulo 15:283–297.

Cope, E. D. 1889. On the Mammalia obtained by the naturalist exploring expedition to southern Brazil. Amer. Nat. 23:128–150.

Cuvier, F. 1829. Mammalogie, list of genera. *In* Dictionnaire des sciences naturelles. Vol. 59. LeNormant, Paris.

Cuvier, G. 1798. Tableau élémentaire de l'histoire naturelle des animaux. Baudoin, Paris.

Dalquest, W. W. 1953. Mammals of the Mexican state of San Luis Potosí. Louisiana State Univ. Stud., Biol. Sci. Ser. 1:1–229.

Davis, W. B. 1955. A new four-toed anteater from Mexico. Jour. Mamm. 36:557–559.

Desmarest, A. 1817. Nouveau dictionnaire d'histoire naturelle. Vol. 12. Chez Deterville, Paris.

Fitzinger, L. J. 1860. Die Ausbeute der osterreichischen Naturforscher . . . Fregatte Novara. Sitz. Akad. Wiss. 42:385–416.

Frantzius, A. 1869. Die Säugethiere Costaricas, ein Beitrag zur Kenntniss der geographischen Verbreitung der Säugethiere Amerikas. Arch. Naturg. 1:247–333.

Geoffroy St.-Hilaire, E. 1803. Catalogue des mammifères du Muséum National d'Histoire Naturelle. Paris.

Gloger, C. W. L. [1841] 1842. Hand-und Hilfsbuch der Naturgeschichte. Aug. Schulz, Breslau.

Goldman, E. A. 1920. Mammals of Panama. Smithsonian Misc. Coll. 69:1–307.

Gray, J. E. 1825. An outline of an attempt at the disposition of Mammalia into tribes and families, with a list of the genera. . . . Ann. Philos., New Ser. 10:337–344.

———. 1843. List of the specimens of Mammalia in the collection of the British Museum. London.

———. 1865. Revision of the genera and species of entomophagous Edentata, founded on the examination of the specimens in the British Museum. Proc. Zool. Soc. London 1865:359–386.

———. 1873a. Hand-list of the edentate, thick-skinned and ruminant mammals in the British Museum. London.

———. 1873b. On Mammalia from the neighborhood of Concordia, in New Granada. Ann. Mag. Nat. Hist., Ser. 4, 11:468–469.

Hagmann, G. 1908. Die Landsäugetiere der Insel Mexiana. Arch. Rassen-GesBiol. 5:1–31.

Hall, E. R. and K. R. Kelson. 1959. The mammals of North America. Vol. 1. Ronald Press Co., New York.

Hershkovitz, P. 1968. Metachromism or the principle of evolutionary change in mammalian tegumentary colors. Evolution 22: 556–575.

Jentink, F. A. 1888. Catalogue systématique des mammifères . . . . Mus. Hist. Nat. Pays-Bas. Vol. 12. E. J. Brill, Leiden.

Krumbiegel, I. 1940. Die Säugetiere der Südamerika-Expeditionen Prof. Dr. Kriegs: 2, Ameisenbären. Zool. Anz. 131:161–188.

Liais, E. 1872. Climats, géologie, faune et géographie botanique du Brésil. Part 2, Faune du Brésil, pp. 301–556. Garnier frères, Paris.

Linné, C. von. 1758. Systema naturae, 10th ed. Vol. 1.

Lönnberg, E. 1937. Notes on some South American mammals. Ark. Zool. 29A:1–29.

McMurtrie, H. 1831. The animal kingdom arranged in conformity with its organization by the Baron Cuvier . . . translated from the French with notes and additions. Vol. 1. New York.

Menegaux, A. 1902. Catalogue des mammifères rapportés par M. Geay de la Guyane Française en 1898 et 1900. Bull. Mus. Natl. Hist. Nat. 8:490–496.

Mertens, R. 1925. Verzeichnis der Säugetier-Typen des Senckenbergischen Museums. Senckenbergiana 7:18–37.

Pallas, P. S. 1766. Miscellanea zoologica, quibus novae imprimis atque obscurae animalium species describuntur et observationibus iconibusque illustrantur. Hagae Comitum.

Palmer, T. S. 1899. Notes on *Tatoua* and other genera of edentates. Proc. Biol. Soc. Wash. 13:71–73.

Pittier, H. and G. H. H. Tate. 1932. Sobre fauna venezolana. Bol. Soc. Venez. Cienc. Nat. 1:249–278.

Reeve, E. C. R. 1942. A statistical analysis of taxonomic differences within the genus *Tamandua* Gray (Xenarthra). Proc. Zool. Soc. London 111A:279–302.

Rüppell, E. 1842. Verzeichniss der in dem Museum der Senckenbergischen naturforschenden Gesellschaft aufgestellten Sammlungen. Mus. Senckenb. 3:144–196.

Saussure, H. de. 1860. Note sur quelques mammifères du Mexique. Rev. Mag. Zool., Ser. 2, 12:3–11.

Schröder, W. 1937. Über Tamandua tetradactyla longicaudata (Wagn.). Zool. Anz. 119:124–138.

Sclater, P. L. 1871. Report on additions to the Society's menagerie in May 1871. Proc. Zool. Soc. London 1871:543–546.

Thomas, O. 1911. The mammals of the Tenth Edition of Linnaeus; an attempt to fix the types of the genera and the exact bases and localities of the species. Proc. Zool. Soc. London 1911: 120–158.

———. 1927. The Godman-Thomas expedition to Peru.—V. Ann. Mag. Nat. Hist., Ser. 9, 19:361–375.

Tomes, R. F. 1861. Report of a collection of mammals made by Osbert Salvin . . . at Dueñas, Guatemala . . . . Proc. Zool. Soc. London 1861:278–288.

True, F. W. 1884. A provisional list of the mammals of North and Central America, and the West Indian Islands. Proc. U.S. Nat. Mus. 7:587–611.

Turner, H. N., Jr. 1851. On the arrangement of the edentate Mammalia. Proc. Zool. Soc. London 1851:205–221.

Vanzolini, P. E. 1973. Paleoclimates, relief, and species multiplication in equatorial forests. Pp. 255–258 *in* B. J. Meggers, E. S. Ayensu, and W. D. Duckworth, eds. Tropical forest ecosystems in Africa and South America: a comparative review. Smithsonian Institution Press, Washington.

Wagler, J. 1830. Natürliches System der Amphibien, mit vorangehender Classification der Säugthiere und Vögel. J. G. Cotta' schen, Munich.

Wagner, J. A. 1844. Die Säugthiere in Abbildungen nach der Natur mit Beschreibungen von Dr. Johann Christian Daniel von Schreber. Suppl. 4:211. Erlangen.

Ximénez, A. 1972. Hallazgo de *Tamandua tetradactyla* (Linné, 1758) en el Uruguay (Edentata-Myrmecophagidae). Neotropica 18: 134–136, plate.

QH
1
B4X
NH

). 12, pp. 113–120 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SMITHSONIAN
AUG 28 1975
LIBRARIES

# FRESHWATER TRICLADS (TURBELLARIA) OF NORTH AMERICA. VIII. *DUGESIA ARIZONENSIS*, NEW SPECIES

By Roman Kenk

*Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560*

Eight species of the genus *Dugesia* Girard are known at present to inhabit the continental Americas north of the Isthmus of Panama. Two of them are widely distributed over the entire North American continent, *Dugesia tigrina* (Girard) and *D. dorotocephala* (Woodworth). *Dugesia microbursalis* (Hyman), which may be a form of *D. tigrina*, has been reported from the northeastern United States. Four species of the genus have recently been described from Mexico by Mitchell and Kawakatsu, *i.e. D. typhlomexicana*, *D. barbarae*, *D. guatemalensis*, and *D. mckenziei*. A European immigrant, *D. polychroa* (O. Schmidt) has been discovered in the waters of the St. Lawrence River system.

Five additional species of *Dugesia* occur on the Caribbean islands: *D. antillana* Kenk in Puerto Rico, *D. cubana* Codreanu and Balcesco in Cuba, *D. aurita* (Kennel) (a somewhat problematic species) and *D. arimana* Hyman on the island of Trinidad, and *D. festai* (Borelli), a South American species, reported from Curaçao.

The new species described in this paper is an additional member of the planarian fauna of the United States.

**Dugesia arizonensis** n. sp.

Figures 1–3, 5

*Type material*: Holotype from Bog Springs, Arizona, on four slides of sagittal sections, deposited in the collections of the National Museum

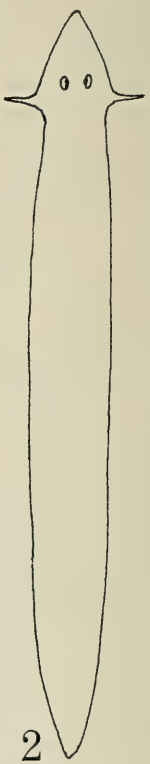



Fig. 1 and 2. *Dugesia arizonensis*. 1. Photograph of living specimen, × 4.6. 2. Outline drawing.

of Natural History, Smithsonian Institution, Washington, D.C. (USNM 51980). Paratypes in the author's collection.

*External features*: (Fig. 1 and 2): At first glance, the species resembles *Dugesia dorotocephala* (Woodworth) by its general appearance. Mature specimens from the type-locality, when gliding quietly, are up to 30 mm long and 4 mm wide. Animals from Rucker Creek appear more slender. The anterior end is triangular and sharply pointed, with a rather acute anterior angle. The two sides of the triangle may appear straight (Fig. 2) or slightly curved (Fig. 1). At the base of the triangle is a pair of long, slender, pointed auricles which in gliding are held elevated. Behind the auricles the body is slightly constricted, then the lateral margins diverge gradually and run almost parallel to the level of the copulatory apparatus, where they converge again to meet at the bluntly pointed posterior end. The two eyes are situated anterior to the level

of the auricles. Their distance from each other amounts to about one-third, or a little more, of the width of the head at eye level.

The color of the animals from Bog Springs is brown, almost black, dorsally and somewhat lighter ventrally. Under magnification, the pigment appears almost uniformly distributed, without lighter specks (such as are usually seen in the related *D. dorotocephala*). The mouth and the genital aperture are marked with small white spots. Specimens from Rucker Creek are lighter in color, grayish, with an almost white ventral surface which, however, shows scattered pigment spots under magnification.

*Digestive system*: The intestinal branching is difficult to analyze in the living specimens, particularly in the darkly pigmented individuals, because of the profuse ramification of the intestinal diverticula. The gut area reaches far into the head to a level anterior to the eyes. The pharynx is rather long, measuring about one-fifth the body length, and is inserted behind the middle of the body. Its surface is uniformly pigmented, light gray, leaving only a short area of the tip free of pigment or white. The anatomy of the pharynx corresponds to that of related species of the same genus. Its external surface is covered by a rather thin, ciliated, infranucleate epithelium (about 3 μm thick) underlain by a narrow layer of longitudinal muscle fibers (4 μm), followed by a thicker sheet of circular fibers (19 μm). There is no internal longitudinal layer developed, such as is seen in some species of *Dugesia* of the Old World. Then follows a wide (130–170 μm) intermediate or mesenchymal zone traversed by numerous pharyngeal gland ducts, the cell bodies of which lie in the mesenchyme anterior to the pharyngeal root. The internal muscle zone consists of two muscle layers, a thinner layer of longitudinal fibers (8 μm) and a wider layer of circular muscles (60 μm). The internal pharyngeal canal is lined with an epithelium (5 μm) which is infranucleate in the posterior and nucleate in the anterior part of the pharynx.

*Reproductive system*: The testes (Fig. 3) are subdorsal, arranged in a pair of longitudinal rows beginning a certain distance behind the ovaries and extending posteriorly to the level of the copulatory apparatus. The region behind the gonopore generally is devoid of testicular follicles. Moderate numbers of testes are located in the dorsal parts of the mesenchyme and in the spaces between the intestinal branches. In the zone of the testes, the yolk glands or vitellaria are developed chiefly in the ventral regions, some of them also reaching to the dorsal side. The thin vasa efferentia descend from the individual testicular follicles ventrally and connect, on either side, with the vas deferens which runs along the ventral nerve cord medial to the oviduct. In the region of the pharynx, the vasa deferentia expand to form the usual contorted spermiductal vesicles filled with masses of sperm.

De Beauchamp (1939: 66) reported that in a South American species of *Dugesia*, "*Euplanaria aurita*" [probably *Dugesia festai* (Borelli)], the testes are usually ventral, particularly in specimens which are not

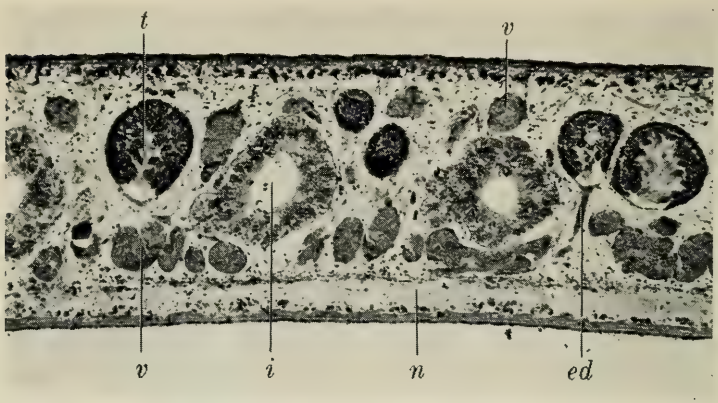



FIG. 3. *Dugesia arizonensis*, parasagittal section of prepharyngeal region, × 74. *ed*, efferent duct; *i*, intestine; *n*, ventral nerve cord; *t*, testes; *v*, vitellaria.

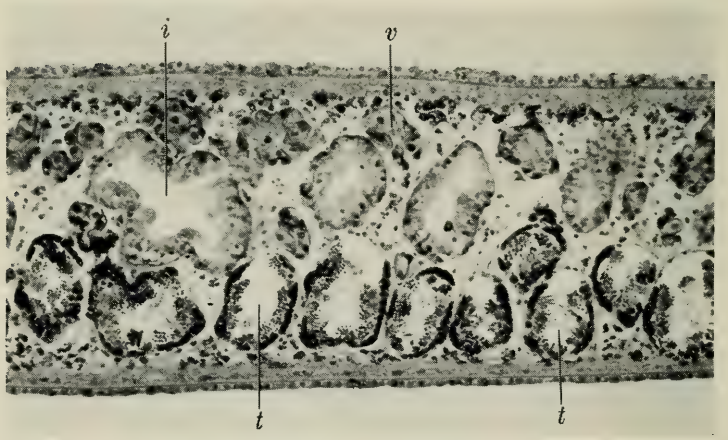



FIG. 4. *Dugesia dorotocephala*, parasagittal section of prepharyngeal region, × 134. Abbreviations as in Fig. 3.

fully mature sexually and have the vitellaria incompletely differentiated. Other specimens, however, with fully developed vitellaria, have the testes located exclusively dorsally. He assumes that there is a migration of the testes at full maturity or possibly after copulation. Ernesto Marcus (1960: 46), on the other hand, observed the testes of *D. festai* to be ventral, occasionally extending throughout the dorsoventral diameter of

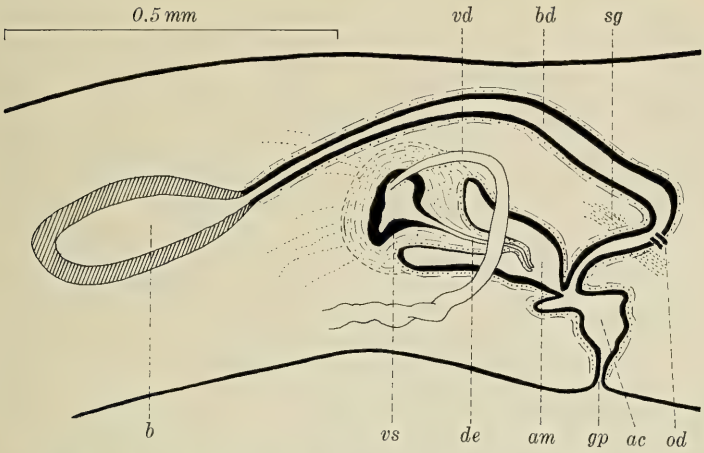



FIG. 5. *Dugesia arizonensis*, semidiagrammatic view of copulatory apparatus in sagittal section. *ac*, common atrium; *am*, male atrium; *b*, copulatory bursa; *bd*, bursal duct; *de*, ejaculatory duct; *gp*, gonopore; *od*, oviduct; *sg*, shell glands; *vd*, vas deferens; *vs*, seminal vesicle.

the body; in only one young individual they were dorsal for a certain distance. Other authors who have examined *D. festai* (Borelli, 1898: 4; Hyman, 1939: 420 [*D. titicacana*]; Eveline Marcus, 1953: 66) indicate that the testes are ventral. Similarly, Ball (1971: 11) reports that he found the testes of *D. arimana* to be predominantly dorsal, except in two specimens, one of which had the testes predominantly ventral on the right side and dorsal elsewhere. The other individual had ventral testes throughout. Ball considers these conditions to be anomalies. Ernesto Marcus (1946: 152) states that in *D. nonatoi* Marcus the testes originate dorsally but, in the fully mature state, are positioned ventrally, with only a few dorsal testes in the postcopulatory region. In *D. hypoglauca* Marcus (1948: 169) the testes are lateral to the vitellaria, originate centrally, but during growth extend to both the dorsal and ventral sides. I have examined sections of 14 mature as well as semimature individuals of *D. arizonensis* and find the testes in the semidorsal position at all stages.

The paired ovaries, lacking parovaria, are situated at a considerable distance behind the brain, at the level of the fourth to sixth lateral branches of the intestinal trunk. The vitellaria, beginning anteriorly to the ovaries, occupy chiefly the ventral region of the mesenchyme, but also extend dorsally through the spaces between the intestinal diverticula.

The copulatory apparatus (Fig. 5) is somewhat removed posterior to the pharyngeal chamber. The genital aperture (*gp*) leads into the

common atrium (*ac*) which receives the mouth of the bursal canal (*bd*) dorsally and connects with the male atrium (*am*) anteriorly. Between the two atria is a conspicuous constriction formed by folds of the atrial wall which leave only a small round opening connecting the two chambers. The epithelium of the common atrium is cuboidal and, at least in part, infranucleate. That of the male atrium is rather thick, cylindrical, and nucleate. The atrial walls have the usual two muscular layers, a circular one and a longitudinal one.

The penis consists of a moderately developed, round bulb and an elongate, very flexible, easily twisted, pointed papilla, covered by a rather flattened epithelium. The bulb contains a lobed cavity, the seminal vesicle (*vs*), lined with a tall, apparently secretory epithelium. Toward the papilla, with a funnel-shaped transition, the cavity extends into a narrow canal, the ejaculatory duct (*de*), which runs through the center of the papilla, opening at the tip. The lining of the duct is a cuboidal to flattened epithelium. Numerous faintly cyanophilic gland ducts enter the penis bulb from the surrounding mesenchyme. The vasa deferentia (*vd*), which approach the copulatory complex as widened spermiductal vesicles, run posteriorly to the level of the male atrium, then curve upward, bend forward, and enter the penis bulb dorsolaterally. This recurving of the sperm ducts is very characteristic and is seen in all mature specimens. Within the tissues of the bulb, the ducts narrow, acquire a coat of circular muscle fibers, and open into the seminal vesicle separately.

The copulatory bursa (*b*) is a rather large, ovoid sac situated at a considerable distance posterior to the pharyngeal pouch. Its outlet, the bursal duct or bursal stalk (*bd*) runs posteriorly above the penis, widening gradually. At the level of the gonopore, or somewhat more posteriorly, it curves ventrally and proceeds anteroventrally to open into the common atrium. It is surrounded by a dense muscular coat, often rather thick, which is somewhat difficult to analyze. Apparently is consists mainly of circular fibers surrounded by longitudinal muscles. Below the downward bend, the bursal duct receives the two oviducts (*od*) entering separately from the sides. In the adjoining section, many eosinophilic gland ducts, the shell glands (*sg*) open into the bursal stalk.

All epithelia of the copulatory complex are nucleate, with the exception of the lining of the common atrium which is, at least partially, infranucleate.

*Distribution and ecology*: *Dugesia arizonensis* was collected by Dr. Peter D'Eliscu in two localities in Arizona:

Bog Springs in Madera Canyon, Santa Rita Mountains, Santa Cruz County (type-locality). 12 May 1972: 8 specimens, some of them semimature, collected on rocks and organic sediment, water temperature 60° F (16° C), pH 7.2. August 1973: Water flow very slow, temperature 20° C, pH 7.4, several specimens collected. 3 November 1973:

Water temperature 14° C, pH 7.4, about 35 specimens, some of them mature.

Rucker Creek (or West Turkey Creek) in Chiricahua Mountains, Cochise County. 22 September 1973: 7 specimens, all immature (some matured later in the laboratory culture), collected about one-half mile upstream from Rucker Lake, water temperature 18° C, pH 6.7.

Hyman (1931: 324) reported that a species of *Euplanaria* (= *Dugesia*) occurred in mountain springs near Tucson, Arizona, in size and shape similar to *D. dorotocephala,* but with a more pointed head and narrower and longer auricles. As no sexual specimens were obtained, she refrained from describing and naming the species (which had been used by Fraps [1930] in his studies on the respiratory and glycolytic metabolism in planarians). It is hightly probable that this species was *Dugesia arizonensis.*

*Behavior in laboratory cultures*: Specimens of the various collections were shipped to me alive and could be maintained in laboratory cultures of dechlorinated (aged) tap water, kept at a temperature of 14° C, and were fed beef liver once a week. Reproduction by fission was observed occasionally. Some of the worms became mature, but no egg capsules were laid in the cultures. The animals have considerable regenerative ability, as is known for all species capable of asexual reproduction by fission. Several individuals were transmitted to Dr. Nicole Gourbault (of the Muséum National d'Histoire Naturelle, Paris) for an analysis of their chromosome morphology.

*Taxonomic relations*: *Dugesia arizonensis* belongs to Ball's (1974: 376) subgenus *Girardia,* which comprises species without penial diaphragm, with the musculature of the bursal stalk consisting of inner circular muscles surrounded by longitudinal fibers, and the testes not confined to the prepharyngeal region. This group has numerous representatives in the Americas and a few in Australia and an Indian Ocean island. The distinctive characters of *D. arizonensis* are the position and number of the testes, the anatomy of the penis, and the configuration of the genital atria. Contrary to the opinion of de Beauchamp (1939: 66), I believe that the location of the testes, whether ventral, dorsal, or intermediate, has some taxonomic significance. A comparison of Figures 3 and 4, showing the arrangement of the testes in *D. arizonensis* and *D. dorotocephala,* illustrates differences which certainly are of systematic value. Cases of secondary displacement of the testes in the course of sexual maturation, such as observed by de Beauchamp (1939: 66) in *D. festai*(?), by Ernesto Marcus (1946: 152) in *D. nonatoi,* and by the latter author (1948: 169) in *D. hypoglauca,* may be exceptional and must be checked by examining individuals in various phases of sexual maturity. Dorsal or semidorsal testes have been reported in 12 of the about 30 species of the subgenus *Girardia.* The pronounced recurving of the vasa deferentia before entering the penis also appears to be a usable characteristic and is known to occur also in

several other species of *Dugesia, e.g. D. dorotocephala.* In the anatomy of the penis, the presence of a large seminal vesicle separates *D. arizonensis* from the group of species with a bifid penial lumen. The slender, pointed, and flexible penis papilla is a unique character within the subgenus. Another very characteristic feature is the separation of the male atrium from the common atrium by the striking constriction or atrial diaphragm, a condition which it shares only with *D. arimana* Hyman (see Ball, 1971: 6).

*Acknowledgments*: I am sincerely thankful to Dr. Peter D'Eliscu for his kind collaboration in procuring ample materials of the new species, and to Dr. John C. Harshbarger of the Smithsonian Institution for his aid in preparing the photomicrographs used in this paper.

## Literature Cited

Ball, I. R. 1971. Systematic and biogeographical relationships of some *Dugesia* species (Tricladida, Paludicola) from Central and South America. Amer. Mus. Novitates No. 2472:1–25.

———. 1974. A contribution to the phylogeny and biogeography of the freshwater triclads (Platyhelminthes: Turbellaria). *In* Biology of the Turbellaria (N. W. Riser and M. P. Morse, ed.): 339–401. McGraw-Hill Book Co., New York.

Beauchamp, P. de. 1939. The Percy Sladen Trust Expedition to Lake Titicaca in 1937 under the leadership of Mr. H. Cary Gilson, M.A. V. Rotifères et turbellariés. Trans. Linn. Soc. London, ser. 3, 1:51–79, pl. 4.

Borelli, A. 1898. Viaggio del Dr. Enrico Festa nell'Ecuador e regioni vicine. IX. Planarie d'acqua dolce. Boll. Mus. Zool. Anat. Comp. Univ. Torino 13(322):1–6.

Fraps, M. 1930. Studies on respiration and glycolysis in *Planaria.* I. Methods and certain basic factors in respiration. Physiol. Zool. 3:242–270.

Hyman, L. H. 1931. Studies on the morphology, taxonomy, and distribution of North American triclad Turbellaria. IV. Recent European revisions of the triclads, and their application to the American forms, with a key to the latter and new notes on distribution. Trans. Amer. Microsc. Soc. 50:316–335.

———. 1939. New species of flatworms from North, Central, and South America. Proc. U.S. Natl. Mus. 86:419–439.

Marcus, Ernesto. 1946. Sôbre Turbellaria brasileiros. Univ. São Paulo, Bol. Fac. Filos. Ciên. Letras, Zool. 11:5–187, pls. 1–31.

———. 1948. Turbellaria do Brasil. Univ. São Paulo, Bol. Fac. Filos. Ciên. Letras, Zool. 13:111–202, pls. 1–20.

———. 1960. Turbellaria from Curaçao. Stud. Fauna Curaçao other Caribb. Isl. 10:41–51.

Marcus, Eveline. 1953. Some South American triclads. Anais Acad. Brasil. Cien. 25:65–78.

No. 13, pp. 121–126 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

AUG 28 1975
LIBRARIES

# *CHIRIDOTEA STENOPS* MENZIES AND FRANKENBERG, A JUVENILE OF *C. ARENICOLA* WIGLEY (CRUSTACEA: ISOPODA)

By Les Watling and Don Maurer
*Marine Studies Center, University of Delaware*
*Lewes, Delaware 19958*

To date, six species of the western Atlantic isopod genus *Chiridotea* Harger have been described (Bowman, 1955; Wigley, 1960, 1961; Menzies and Frankenberg, 1966). Of these, two (*C. almyra* Bowman and *C. nigrescens* Wigley) occur in brackish water while the remaining species [*C. coeca* (Say), *C. tuftsi* (Stimpson), *C. arenicola* Wigley, and *C. stenops* Menzies and Frankenberg] occur in marine waters. Until the description of *C. stenops by* Menzies and Frankenberg (1966), a common feature of the genus was the presence of deep clefts in the lateral cephalic margins. Menzies and Frankenberg (1966) commented that *C. stenops* was unique in possessing lateral cephalic margins that were not incised and thus it did not appear to be very closely related to any other species in the genus. It is the purpose of this paper to show that the lack of incised lateral cephalic margins is characteristic of immature *Chiridotea* and that *C. stenops* is a juvenile of *C. arenicola.*

## Material Examined

Specimens examined were obtained from the following sources: a) the paratypes of *C. stenops* (USNM 111072) and *C. arenicola* (USNM 104281) were obtained from the U.S. National Museum; b) several individuals were obtained from a series of samples taken on the Delaware-Maryland continental shelf by the Environmental Protection Agency; c) a

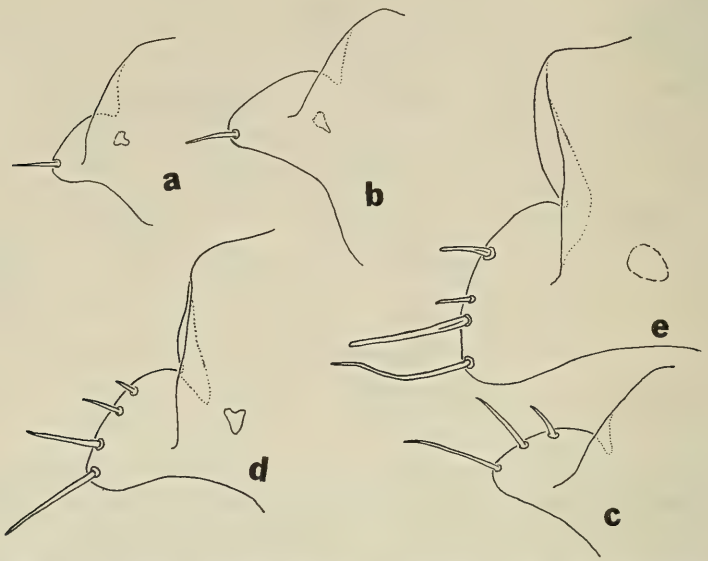



Fig. 1. Lateral cephalic margin of several *Chiridotea* specimens. a, *C. stenops* paratype, 2.5-mm body length; b, *C. stenops* paratype, 3.0 mm; c, specimen from continental shelf off Delaware, 4.0 mm; d, *C. arenicola* paratype, male, 5.0 mm; e, *C. arenicola* paratype, female, 6.5 mm. a, b, d, e, drawn to scale different from c.

series of specimens of *C. tuftsi* from Massachusetts Bay were obtained from the U.S. National Museum.

## Results and Discussion

Menzies and Frankenberg (1966) listed the following features as being diagnostic of *C. stenops*: (1) lateral margin of cephalon not deeply incised; (2) preocular region of cephalon narrow as compared to the produced postocular region; (3) apex of pleotelson with only three to five lateral setae; and (4) eyes reduced, almost obscure. To establish which characters varied with increasing size, the paratypes of *C. stenops* and *C. arenicola* and locally obtained specimens from the Delaware-Maryland shelf were examined for the following characteristics: size of the cleft in the lateral cephalic margin; number of spines on antenna 2 peduncle segment 4; num-

TABLE 1. Change in value of selected features with increasing body length.

| Source of Specimen | Length (mm) | No. spines antenna 2, peduncle segment 4 | No. flagellar segments, antenna 2 | No. spines, lateral margin telson apex |
|---|---|---|---|---|
| 1. *C. stenops* paratype | 2.5 | 3 | 2 | 3 |
| 2. *C. stenops* paratype | 3.0 | 3 | 2(3)[a] | 2–3 |
| 3. Off Bethany Beach, De. | 3.0 | 5 | 2(3) | 4 |
| 4. Mid-Atlantic shelf, 38°11.9′N, 74°32.9′W | 3.0 | 5 | 2 | 4 |
| 5. Off Bethany Beach, De. | 3.5 | 5 | 3 | 3 |
| 6. Off Bethany Beach, De. | 4.0 | 5 | 2(3) | 5 |
| 7. Mid-Atlantic shelf, 38°11.9′N, 74°32.9′W | 4.0 | 6 | 3 | 4 |
| 8. *C. arenicola* paratype ♂ | 5.0 | 8 | 3 | 5 |
| 9. Mid-Atlantic shelf, 38°23.8′N, 74°15.3′W | 5.0 | 7 | 3(4) | 4 |
| 10. Mid-Atlantic shelf, 38°11.9′N, 74°32.9′W | 5.5 | 9 | 4 | 8 |
| 11. *C. arenicola* paratype ♀ | 6.5 | 10 | 4 | 9 |
| 12. Off Delaware Bay, 38°47.5′N, 74°45.5′W | 6.5 | 11 | 4 | 7 |
| 13. Off Bethany Beach, De. | 6.5 | 9 | 4 | 8 |

[a] The numbers in parentheses indicate that within the exoskeleton of one of the segments, two new segments were visible.

ber of antenna 2 flagellar segments; and number of spines on the lateral margins of the telson apex.

The changes in the lateral cephalic margins are documented in Figure 1 and the values for the other characters examined are given in Table 1. While neither of Menzies and Frankenberg's (1966) paratypes possessed a distinct cleft to divide the lateral cephalic margin into pre- and post- ocular lobes, there was a slight ventral indentation just forward of the eye. As larger specimens were examined, the cleft became more distinct and the preocular lobe more quadrate as in the *C.*

FIG. 2. *Chiridotea tuftsi*, from Massachusetts Bay, USNM 35258, 2.0 mm body length: a, lateral cephalic margin; b, second antenna, peduncle segment 5 and 2 flagellar segments.

*arenicola* paratypes (Fig. 1). Similarly, the number of spines on the postocular lobe increases from 1 on the Menzies and Frankenberg specimens to 4 on Wigley's specimens of *C. arenicola*. The values for the other characters listed in Table 1 also changed with increasing body length.

To substantiate that the changes in the above features were related to the age of the individuals, several specimens of the very distinct *C. tuftsi* were also examined. Individuals of this species, regardless of their size, can be recognized by the presence of several strong spines on the inner margin of the dactyl of pereopod 1. It was observed (Fig. 2) that the lateral cephalic margins of a 2.0-mm specimen (USNM 35258) showed a striking resemblance to the paratypes of Menzies and Frankenberg (1966). As larger individuals were examined, the cleft in the lateral cephalic margin became more distinct and the preocular lobe much more pronounced. Similarly, the number of spines on both the pre- and post- ocular lobes increased with increasing body length. Other features, such as the number of antenna 2 flagellar segments, also increased.

On the basis of the evidence presented, it is concluded that *Chiridotea stenops* Menzies and Frankenberg (1966) is a synonym of *Chiridotea arenicola* Wigley (1960). It is also suggested that *C. nigrescens* and *C. coeca* be re-examined to determine if there is a similar gradational change in characters between those two species.

ACKNOWLEDGMENTS

We would like to thank Dr. Thomas E. Bowman for the loan of the U.S. National Museum specimens and for his en-

couragement of this study. We are also indebted to Dr. Donald Lear of the Environmental Protection Agency, Regional Field Office, Annapolis, Maryland, for obtaining specimens from the Delaware-Maryland continental shelf.

## Literature Cited

Bowman, T. E. 1955. The isopod genus *Chiridotea* Harger, with a description of a new species from brackish waters. Jour. Washington Acad. Sci. 45(7):224–229.

Menzies, R. J., and D. Frankenberg. 1966. Handbook on the common marine isopod Crustacea of Georgia. University of Georgia Press, Athens, Ga., 93p.

Wigley, R. L. 1960. A new species of *Chiridotea* (Crustacea: Isopoda) from New England waters. Biol. Bull. 119(1):153–160.

———. 1961. A new isopod, *Chiridotea nigrescens*, from Cape Cod, Massachusetts. Crustaceana 2(4):286–292.

No. 14, pp. 127–140 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

AUG 27 1975
LIBRARIES

# THE OPHIACANTHID GENUS *AMPHILIMNA* (OPHIUROIDEA, ECHINODERMATA)

By Lowell P. Thomas
*Rosenstiel School of Marine and Atmospheric Science, Division of Biology and Living Resources, University of Miami, Miami, Florida 33149*

Until recently *Amphilimna* Verrill, 1899 was considered an amphiurid genus and considerable confusion existed regarding the systematic characters of the type-species, *Amphilimna olivacea* (Lyman, 1869). Some of the mystery surrounding this species was cleared up when it was discovered (Thomas, 1967) that *A. olivacea* is not an amphiurid, and that a second nominal species, *A. caribea* (Ljungman, 1871), belongs in the ophiocomid genus *Ophiopsila.* Unfortunately, I considered *Amphilimna* reduced to monotypic status by my studies, overlooking a species described from the Philippines 45 years earlier (*A. multispina* Koehler, 1922). Consequently, as of 1967 *Amphilimna* actually included two nominal species, *A. olivacea* and *A. multispina.*

Thomas and Schoener (1972) suggested that *Amphitarsus* H. L. Clark, 1941, with two species, *A. mirabilis* H. L. Clark, 1941, and *A. nike* Schoener, 1967 should probably be considered a junior synonym of *Amphilimna.* Devaney (1974), describing a new species of *Amphilimna* from Pitcairn Island, acted upon this suggestion by making *Amphitarsus* a junior synonym of *Amphilimna.* Unfortunately, Devaney also overlooked Koehler's Pacific species, considering his own new one, *A. tanyodes,* the first known from the Pacific. Another species of *Amphilimna, A. cribriformis* was described from southern Africa by A. M. Clark in 1974 in a paper published about the same time as Devaney's. Finally, during a visit to the British

Museum (Nat. Hist.) in the summer of 1974, I discovered, as A. M. Clark (1974) had suggested, that *Anamphiura valida* H. L. Clark is in fact an *Amphilimna*; thus, including the latter species as a new combination, there are now seven species in the genus *Amphilimna*: *A. olivacea* (Lyman, 1869), *A. multispina* Koehler, 1922, *A. nike* (Schoener, 1967), *A. mirabilis* (H. L. Clark, 1941), *A. tanyodes* Devaney, 1974, *A. cribriformis* A. M. Clark, 1974, *A. valida* (H. L. Clark, 1939) new combination.

In the following account I have included only selected references in the synonymies. These references should be consulted for more complete synonymies. The diagnoses have been deliberately kept short. As more material of the poorer known species becomes available, expanded diagnoses will undoubtedly appear. Similarly the keys to the species must be considered provisional, subject to future elaboration and revision.

Through the years, while working on *Amphilimna* and other genera, I have been assisted by Maureen Downey and David Pawson of the United States National Museum of Natural History (hereafter abbreviated USNM); Elizabeth Deichmann, H. Barraclough Fell, Charlene Long, and Amy Schoener of the Museum of Comparative Zoology at Harvard (MCZ); and Ailsa Clark of the British Museum (Natural History) (BM). Mary Anna Bogle assisted with most of the technical work for this paper, and Claire Ulanoff made the illustrations of *A. nike*. I am grateful to all for their long and valued assistance and friendship, and particularly for their patience when it appeared academic and other responsibilities would preclude my completing some of the research projects I had begun. I am also grateful to Linda Pequegnat of Texas A & M University who arranged for me to look at the collection in which a fine large specimen of *A. nike* was discovered and to Dennis Devaney who kindly edited my diagnosis of his new species.

This study has been conducted with the support of the following grants in aid for research from the National Science Foundation which I thankfully acknowledge: NSF GB 16556 and NSF GB 39871.

OPHIACANTHIDAE

*Amphilimna* Verrill, 1899

*Amphilimna* Verrill, 1899: 30.—Thomas, 1967: 123.—Devaney, 1974: 122.

*Amphitarsus* H. L. Clark, 1941: 83.

*Diagnosis*: The following is based upon consideration of the 7 nominal species listed above which presently constitute the genus *Amphilimna*. The differences between this diagnosis and Devaney's (1974) are discussed below: Disc notched at radial shields; radial shields variable in size and shape; disc scales covered to varying degrees by spines, spinelets, and/or granules. Two to 6 oral papillae at apex of jaw, 2 or 3 at or near distal end of jaw around second oral tentacle pore, 1 or more papillae (1 an oral tentacle scale?) between distal and apical clumps of papillae. Some arm spines under disc flattened and fused together forming peculiar "flanges" in the genital slits. Ventral arm plates abruptly widen distally. Proximal arm segments usually with 2, occasionally to 5, tentacle scales, 1 to 3 on lateral arm plate, 1 or 2 usually arising from middle of side of ventral arm plate; tentacle scales spiniform, round and flat, or some intermediate condition.

*Discussion*: Devaney's (1974) treatment and diagnosis of *Amphilimna* requires some modification and comment, partly because of the addition of more species to the genus. The following range of variation may be found if one considers all 7 species: The distal oral papillae, bordering the outermost tentacle pores, are not necessarily "squamiform," but may be either round and very flat, spiniform, or of some intermediate condition. There is, varying in expression from species to species, a tendency for the proximal oral papillae to occur in a distinct cluster at the jaw apex. The distal and proximal groups of papillae are usually separated from one another by 1 or more papillae (including what seem to be oral tentacle scales). The ventral arm plates of all species widen abruptly at their distal ends, a condition I consider of generic importance. With the addition of *A. valida* to *Amphilimna* the arm length to disc diameter ratio deviates considerably from Devaney's figure of "six or more times disc diameter." The arm length may be only 2 times the disc diameter in *A. valida*, and the ratio for ophiuroids in general is probably useful only within specific size classes of individual species.

Earlier (Thomas, 1967: 125) I discussed the dental plates of *Amphilimna olivacea* and pointed out their similarities with those of other ophiacanthid genera, but I also suggested that *Ophioprium cervicorne* (Lyman, 1883) was closely related to *A. olivacea*. After examining the holotype of *O. cervicorne* I still believe the 2 genera are quite closely related. Devaney has suggested that *Amphilimna* shows affinities with a group of 6 genera, with large tentacle pores, indicated by Matsumoto (1917) and (possibly?) with 2 genera included in that group by Fell (1960). Two of the genera Devaney lists seem to be synonyms of other

genera and the affinities of the 8 nominal genera with *Amphilimna* vary, in my opinion, from none whatsoever to a definite affinity in the case of *Ophioprium*. Considering the genera in question, *Ophiopora* Verrill, 1899 is treated by Fell (1960) as a synonym of *Ophiotoma* Lyman, 1883, whose type-species, *Ophiotoma coriacea* Lyman, 1883, except for lacking tentacle scales, looks vaguely like an *Amphilimna*. *Ophiopristis* Verrill, 1899 is considered a synonym of *Ophiacantha* Müller and Troschel, 1842 by Fell (1960) but it seems to be misplaced here, as the type-species of *Ophiopristis*, *O. bartletti* Lyman, 1883, has large tentacle pores and looks very much like an *Ophiotoma*. The remaining genera in Devaney's list are *Ophiambix* Lyman 1880, *Ophiomedea* Koehler, 1906, *Ophiotrema* Koehler, 1896, *Ophiodelos* Koehler, 1931, *Glaciacantha* Fell, 1961 and *Ophioprium*, Clark, 1915. The type-species of *Glaciacantha*, *Ophiodelos*, and *Ophiambix*, in my opinion, cannot be considered as having any "affinity" with *Aphilimna*. The type-species of *Ophiomedea*, *O. duplicata* Koehler, 1906, has a similar tentacle scale arrangement and in other ways looks vaguely similar to *A. olivacea*, as does the type-species of *Ophiotrema*, *O. alberti* Koehler, 1896, which has naked radial shields, spines on the disc, large tentacle pores with tentacle scales on both the lateral arm plates and ventral arm plates.

The major problem in determining relationships of other genera with *Amphilimna* appears to me to be in determining the generic characteristics of *Amphilimna* itself. Aside from the flattened fused arm spines under the disc, the features which seem to be most characteristic of this genus are the shape of the ventral arm plates and the arrangement of the tentacle scales around the large tentacle pores, the presence of the oral papillae, notches in the disc at each radial shield pair, and the presence of spines or granules on the disc. Characters which vary from species to species include the relative size and shape of the radial shields (these vary also with the size of the individual), the disc covering, the shape and numbers of oral papillae, the shape and numbers of tentacle scales, and the number of arm spines.

### *Amphilimna olivacea* (Lyman, 1869)

*Ophiocnida olivacea* Lyman, 1869: 340.
*Amphitarsus spinifer* Schoener, 1967: 269.
*Amphilimna olivacea*: Thomas, 1967: 123, figs. 1–6.—Madsen, 1970: 163, fig. 5.—Tommasi, 1970: 32, figs. 30, 31—A. M. Clark, 1974: 444 [in discussion].—Devaney, 1974: 121 [in discussion].

*Material Studied*: 14 spec.; Gosnold Sta. 1074; northeast of Hudson Canyon (39°43.0′N, 71°53.2′W), 225 m; 12 May 1963.—6 spec.; Gosnold Sta. 1261; Block Canyon (40°00.0′N, 71°16.8′W), 235 m; 4 October 1963.—4 spec.; Gosnold Sta. 1571; off Florida Keys (24°32.0′N, 81°16.5′W), 89 m; 31 May 1964.—6 spec.; Gosnold Sta. 1572; off Florida Keys (24°29.3′N, 81°27.7′W), 97 m; 31 May 1964.

*Diagnosis*: Jaws with 2 or 3 papillae at apex, 2 or 3 slender, pointed oral papillae bordering each oral tentacle pore; 1 papilla (probably an oral tentacle scale) separating infradental papillae and papillae arising from oral tentacle pore. Oral shield rhomboidal, wider than long; adorals meeting or nearly meeting proximally; arms slender, 6 times disc diameter in large specimen, 8 to 10 proximal arm plates with 2 tentacle scales at each tentacle pore, innermost attenuated, arising from middle of ventral arm plate; beyond tenth ventral arm plate innermost absent; 7 or 8 slender arm spines, ventralmost longest; all but ventral 2 or 3 arm spines of arm segments under disc greatly flattened, fused with others to form peculiar flanges occupying genital slits; dorsal arm plates slightly wider than long. Disc scales studded with slender spines. Radial shields narrow, about 3 times longer than wide, joined proximally, slightly separated distally; disc deeply notched at each pair of radial shields. Two slender spines at distal ends of genital plates near junction with radial shields. Color variable, disc gray, tan or brown, arms pink or orange.

*Discussion*: With its slender disc spines, attenuated inner tentacle scales, and slender oral papillae, *O. olivacea* appears to be most similar to *A. cribriformis*. It differs in having a rhomboidal oral shield, contiguous or nearly contiguous adorals, longer arm spines, and in a variety of other details discussed by A. M. Clark (1974: 444).

*Distribution*: Widespread in the Atlantic Ocean from 60 to 350 m. Perhaps extending to nearly 500 m (Verrill, 1899b: 377). Liberia to Angola in the eastern Atlantic, Massachusetts to Uruguay in the western Atlantic.

### *Amphilimna cribriformis* A. M. Clark, 1974

*Amphilimna cribriformis* A. M. Clark, 1974: 442, Fig. 1.

*Material Studied*: None.

*Diagnosis* (modified after A. M. Clark, 1974): Jaws with 2 to 4 infradental papillae at apex, 3 slender, pointed oral papillae bordering each oral tentacle pore; one papilla (probably an oral tentacle scale) separating apical and distal oral papillae. Oral shields triangular, broadest distally; adoral plates separated at proximal angle of oral shield. First 8–10 arm segments bearing 2 tentacle scales, innermost arising from middle of ventral arm plate, initially long and slender; beyond tenth or twelfth ventral arm plate innermost absent; outermost arising from lateral arm plate, short, becoming flattened toward distal end of arm. Six or fewer arm spines each arm segment, under disc all but ventral spine flattened and fused to form peculiar flanges occupying genital slits; dorsal arm plates beyond first few ovate, broader than long, thin, semitransparent. Disc scales studded with slender spines. Radial shields long, narrow, joined proximally, slightly separated distally; disc somewhat notched at each pair of radial shields. Two spines

stouter than disc spines at distal ends of genital plates near junction with radial shields.

*Discussion*: A. M. Clark (1974) described this species in detail. It differs from *O. olivacea*, with which it seems most similar, in having triangular oral shields, slightly separated adoral shields, shorter arm spines which are never as long as an arm segment, 2–4 infradental papillae rather than 2–3, and in the oval shape and transparent, delicate nature of the dorsal arm plates.

*Distribution*: Known only from along the continental shelf of eastern South Africa and southern Mozambique, 86 to 200 m.

### *Amphilimna multispina* Koehler, 1922

Figure 1

*Amphilimna multispina* Koehler, 1922: 183, p. 61, figs. 4–9, pl. 96, fig. 7

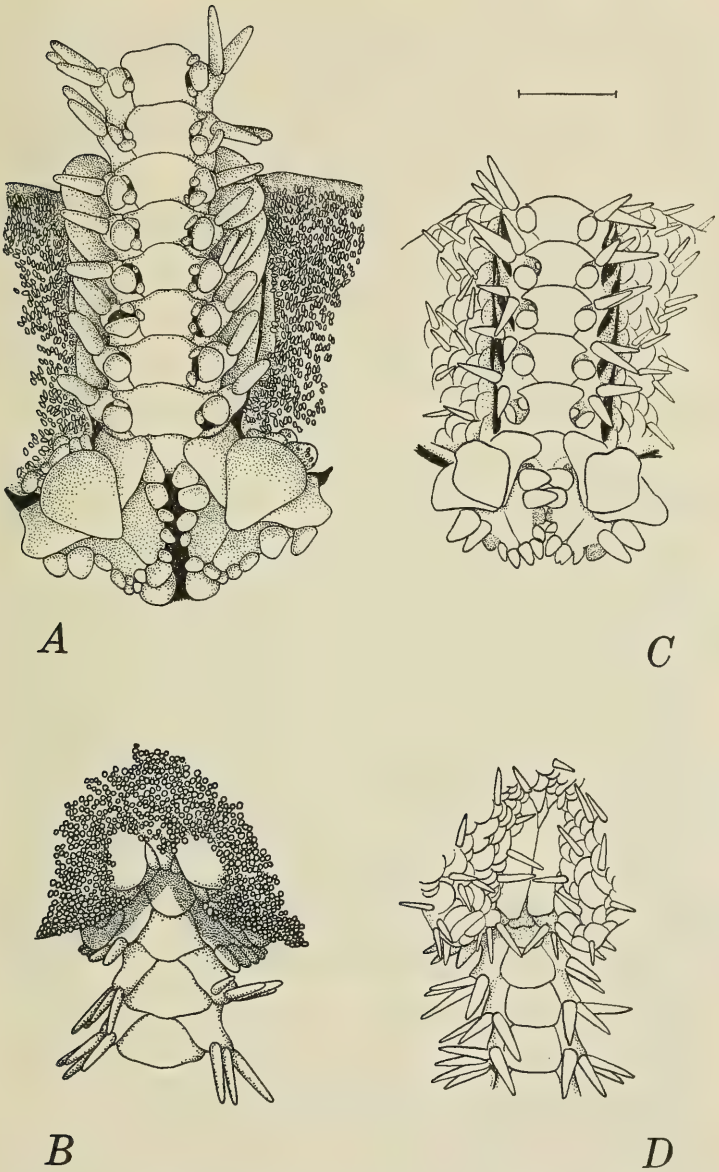
*Material Studied*: 1 spec. (paratype); Albatross Sta. 5220; between Marinduque and Luzon, Philippines (13°38′00″N, 121°58′00″E), 91 m; 24 April 1908; USNM Cat. No. E 23.—13 spec. (paratypes); Albatross Sta. 5221; between Marinduque and Luzon, Philippines (13°38′15″N, 121°48′15″E), 335 m; 24 April 1908; USNM Cat. No. E 26, E 27.—4 spec. (paratypes); Albatross Sta. 5222; between Marinduque and Luzon, Philippines (13°38′30″N, 121°42′45″E), 357 m; 24 April 1908; USNM Cat. No. E 25.—1 spec. (paratype); Albatross Sta. 5223; between Marinduque and Luzon, Philippines (13°36′00″N, 121°25′30″E), 357 m; 24 April 1908; USNM Cat. No. E 24.—4 spec. (paratypes); Albatross Sta. 5375; Marinduque Island and vicinity, Philippines (13°42′15″N, 121°50′15″E), 196 m; 2 March 1909; USNM Cat. No. E 4.

*Diagnosis*: Jaws with one or 2–6 short blunt papillae at apex, 2 large broadly flattened papillae longer than wide bordering each oral tentacle pore, oral papilla (probably an oral tentacle scale) separating infradental papillae and papillae arising from oral tentacle pore. Oral shield almost twice longer than wide, arrowhead shaped, pointed proximally, broadly rounded distally. Adoral shields joined at distal end of oral papillae except in very large specimens. Arms slender, probably at least 6 times as long as disc diameter. Tentacle scales flattened, oval, scale arising from lateral arm plate largest, completely covering tentacle pore, smaller similarly shaped scale arising from side of ventral arm plate for first 8–10 segments; 6–9 arm spines, slender, flattened, dorsalmost longest, longer than an arm segment. All but ventral 2 or 3 spines

---

→

Fig. 1. A, *Amphilimna nike*, Gosnold Sta. 1580, oral view, two jaws and base of arm. B, *A. nike*, Gosnold Sta. 1580, radial shields and base of




arm. C, *A. multispina*, Paratype, ALBATROSS Sta. 5221, oral view, two jaws and base of arm. D, *A. multispina*, Paratype, ALBATROSS Sta. 5221, radial shields and base of arm. Scale equals 1 mm.

of each side arm plate under disc flattened, fused with others to form peculiar flanges occupying genital slits. Disc scales studded with slender spines; radial shields narrow, 3–4 times longer than wide, usually slightly separated at their distal ends. Disc deeply notched at each pair of radial shields. One to 3 slender spines at distal ends of genital plates near junction with radial shields. Color pale tan, arms lightly banded with darker brown.

*Discussion*: *Amphilimna multispina* bears large, round, flattened tentacle scales like those of *A. valida*, *A. nike*, *A. mirabilis*, and *A. tanyodes*. It differs from the last three, however, in possessing slender spines rather than granules or granulose spinules on the disc. The possible relationship of *A. multispina* with *A. valida* or *A. tanyodes* is discussed under those species.

*Distribution*: Known only from Koehler's (1922, p. 183) original material near Marinduque Island in the Philippines, 91 to 357 m.

*Amphilimna valida* (H. L. Clark, 1939) new combination

*Anamphiura valida* H. L. Clark, 1939: 70, figs. 26a, 27.—A. M. Clark, 1974: 478, fig. 16.

*Material Studied*: 1 spec. (holotype); John Murray Exped. Sta. 105; off Zanzibar, 238–293 m; 11 January 1934; BM 1948.5.26.87.

*Diagnosis*: Jaws with 2–4 papillae at apex, 2 or 3 papillae around oral tentacle scale, one oral papilla (probably an oral tentacle scale) between the two groups. Oral shield rhomboidal, wider than long. Adorals meet at proximal end of oral shield. Arms short, only 2 or 3 times longer than disc diameter. First 3–6 arm segments bear 2 tentacle scales at each tentacle pore, 1 on lateral arm plate round, flattened, large, 1 on side of ventral arm plate smaller, round or conical. Thereafter only large outer scale. First 1 or 2 arm segments bear some arm spines flattened and coalesced into "flange," 2 ventral spines free. Five or 6 arm spines on segments nearest disc; lowest longest, equalling or longer than arm segment, uppermost shortest, one-half length of arm segment. Disc scales include large primitive plates, scattered slender spines on disc. Radial shields short, up to 2 times longer than wide, joined proximally, widely separated distally, disc notched at distal ends of radial shields.

*Discussion*: Although *A. valida* as presently known has all the characteristics of a young specimen and consequently may be a synonym of another species, there are characters that suggest it is distinct. The broad rhomboidal oral shield is conservative in *A. olivacea* and presumably so in *A. valida* as well. This shape shield, combined with slender disc spines, occurs in no other nominal Pacific species of *Amphilimna*. Otherwise *A. valida* appears most similar to *A. multispina* which has similar tentacle scales and slender disc spines.

*Distribution*: Known only from John Murray Sta. 105, Zanzibar area

238–293 m (H. L. Clark, 1939), and near Tugela River mouth, 350 m (A. M. Clark, 1974).

### *Amphilimna mirabilis* (H. L. Clark, 1941)

*Amphitarsus mirabilis* H. L. Clark, 1941: 83, pl. 8.—Schoener, 1967: 2, fig. 1.
*Amphilimna mirabilis*: Devaney, 1974: 22.

*Material Studied*: 1 spec. (holotype); Atlantis Sta. 3402; off Cayo Coco, Camaguey Province, 420 m; MCZ 6232.—1 spec. (paratype); Atlantis Sta. 3332; Bahia de Cochinos, Santa Clara Province, Cuba, 320–412 m; MCZ 6398.—1 spec. (paratype); Atlantis Sta. 3422; off Caibarien, Santa Clara Province, Cuba, 430 m; MCZ 6399.

*Diagnosis*: Jaws with 3 or 4 oral papillae at apex of jaw, 2 or 3 flat, round papillae guarding oral tentacle pore; 2 groups of oral papillae separated by (probably oral tentacle scale) oral papilla. Oral shield rhomboidal, slightly wider than long with rounded angles. Adoral shields meeting at distal side of oral shields. Arms slender, more than 6 times disc diameter, segments under disc with arm spines flattened and fused forming flanges, 1 or 2 ventral spines free. Eight or 9 arm spines near disc, ventralmost longest. Tentacle scales round, flat, largest arising from lateral arm plate, 1 or 2 smaller ones arising from side of ventral arm plate of basal arm segments. Disc scales thickly studded with tiny spinules and granules. Radial shields narrow, 4 times longer than wide, separated their distal third, disc deeply notched at each pair of shields, several slender spines arising from each genital plate within notch. Color, disc grayish white, arms yellowish white.

*Discussion*: *Amphilimna mirabilis* seems to be most similar to *A. nike* and *A. tanyodes*, the only other species with granules or closely grouped spinules rather than slender spines on the disc. It differs from *A. nike* in having at least twice as many arm spines, a much more dense covering of granules, much longer radial shields and in the adoral shields meeting at the distal side of the oral shields. *Amphilimna tanyodes* appears to be more like *A. mirabilis* in the above and other characters but seems to have somewhat longer spinules on the disc. In view of the distribution of the 2 species, *A. tanyodes*, though similar, must be distinct from *A. mirabilis*.

*Distribution*: Has been taken only off the north and south coasts of Cuba, 320 to 430 m.

### *Amphilimna nike* (Schoener, 1967)

Figure 1

*Amphitarsus nike* Schoener, 1967: 2, fig. 2.
*Amphilimna niki*: Devaney, 1974, p. 122 [lapsus].

*Material Studied*: 1 spec. (holotype); WHOI Chain cruise 35, Dredge Sta. 33; 140 miles north of Surinam (7°53.5'N, 54°33.3'W),

535 m; 25 April 1963; MCZ 6797.—1 spec.; disc diameter 10 mm; Gosnold Sta. 1580; off Florida Keys (24°10.0'N, 81°22.0'W), 681 m; 1 June 1964.—1 spec.; Texas A&M cruise 69A11, Sta. 58; off Veracruz, Mexico (19°02.6'N, 95°27.5'W), 476 m; no date (specimen returned to Texas A&M).

*Diagnosis*: Oral papillae varying from jaw to jaw, 2–4 small papillae at apex of each jaw, 1 or 2 large round flattened papillae distally at each oral tentacle pore, occasionally a smaller papilla also, apical and distal groups separated by 1 or 2 small papillae (probably oral tentacle scales). Oral shields slightly longer than wide, roughly pentagonal with proximolateral sides meeting at a rounded angle and distolateral sides meeting a distal side. Adoral shields widely separated by oral shields. Arms probably 6 or more times disc diameter; arm spines under disc flattened and fused to form flanges except ventralmost which is free. Large, round, flattened tentacle scale arising from lateral arm plate, 1 or 2 much smaller scales arising from sides of ventral arm plates of proximal arm segments for varying distances along arm. Three or 4 slender arm spines, longest about as long as arm segment. Dorsal arm plates wider than long, often slightly separated by lateral arm plates. Disc scales covered by scattered conical granules often as far apart as 2 or 3 times diameter of granule; granules giving way to spinules on ventral surface of disc. Radial shields separated, only one and one-half times longer than wide, broadest distally; disc notched at each pair of radial shields.

*Discussion*: *Amphitarsus nike* and *A. mirabilis* both display considerable variation in their oral armature. Fortunately they seem easily separable by other characters, particularly the number of arm spines and proportions of the radial shields. In addition to the smaller specimens of the type material, *A. nike* is now known from a specimen with a disc diameter of 10 mm (see material studied).

*Distribution*: Known from the type-material collected in the tropical Atlantic 140 miles north of Surinam at 535 m and other material from the Gulf of Mexico off Veracruz, Mexico at 476 m, and in the southern Straits of Florida at 681 m.

### *Amphilimna tanyodes* Devaney, 1974

*Amphilimna tanyodes* Devaney, 1974: 116, figs. 1–5.

*Material Studied*: None.

*Diagnosis* (modified after Devaney, 1974): Two to 4 small papillae extending around proximal end of jaw; 2 large round or oval papillae at each oral tentacle pore; papillae of proximal end of jaw separated from group at oral tentacle pore by 2 or 3 papillae, one nearest those at oral tentacle pore largest. Oral shields about as wide as long, bluntly pointed proximally, slightly lobed distally. Adoral shields meeting (or nearly so) at proximal end of oral shields. Arms slender, long,

more than 10 times disc diameter. At size of 6–7 mm, 2 tentacle scales regularly to ninth arm segment, irregularly to 17th segment, single scale beyond; outer scale largest, oblong with rounded tip, flat, arising from side arm plate; inner scale smaller, more tapering, arising from ventral arm plate. Seven to 8 arm spines near disc; 1 to 3 lower arm spines on each lateral arm plate under disc unmodified, upper spines flattened and fused to form flanges; spines forming flanges divided beyond base. Disc scales studded with granules above, more widely spaced spinules below. Radial shields 3 times longer than wide, slightly separated proximally, more widely separated distally; disc notched at each pair of radial shields; 2 to 4 bluntly tipped spines at junction of radial shield and genital plate.

*Discussion*: *A. tanyodes*, except for having granules and small spines (spinules) on the disc, appears rather similar to *A. multispina* Koehler.

### Remarks On The Genus *Amphilimna*

The seven nominal species of *Amphilimna* considered here seem to fall into three groups of similar species, one consisting of *A. olivacea* and *A. cribriformis*, one consisting of *A. multispina* and *A. valida*, and one consisting of *A. nike*, *A. mirabilis* and *A. tanyodes*. Unfortunately, so little is known about five of the seven species I feel it is impossible, at present, to construct a completely satisfactory key. The following provisional key may serve to assist in the identification of the species provided recourse to the diagnosis is made.

### Provisional Key to the Species of *Amphilimna*

1. On basal arm segment innermost tentacle scales (arising from ventral arm plates) long and slender, longer than outer scales arising from lateral arm plates ..... 2
   On basal arm segments innermost tentacle scales round and flattened, or occasionally absent or granular, not long and slender, shorter than outer tentacle scale ..... 3
2. Oral shield rhombic with angular or curved distal side ..... *A. olivacea*
   Oral shield triangular with straight distal side ..... *A. cribriformis*
3. Disc scales of upper surface bear scattered spinelets ..... 4
   Disc scales of upper surface bear closely clustered tiny short spinelets and/or granules ..... 5
4. Oral shield longer than wide, 6–9 arm spines ..... *A. multispina*
   Oral shield wider than long, 6 or fewer arm spines ..... *A. valida*
5. Four arm spines or fewer, radial shields oval or round, as wide as long ..... *A. nike*
   Six or more arm spines, radial shields at least twice as long as wide ..... 6
6. Atlantic species ..... *A. mirabilis*
   Pacific species ..... *A. tanyodes*

## Literature Cited

Clark, A. M. 1974. Notes on some echinoderms from southern Africa. Bull. Brit. Mus. Nat. Hist. (Zool.) 26(6):421–487, 16 text-figs., 3 pls.

Clark, H. L. 1915. Catalogue of recent ophiurans based on the collection of the Museum of Comparative Zoology. Mem. Mus. Comp. Zool. Harvard 25(4):165–376, pls. 1–20.

———. 1939. Ophiuroidea. Scient. Rep. John Murray Exped. 6:29–136, 62 figs.

———. 1941. Reports on the scientific results of the Atlantis expeditions to the West Indies, under the joint auspices of the University of Havana and Harvard University. The echinoderms (other than holothurians). Mem. Soc. Cubana Hist. Nat. 15(1):1–154, pls. 1–10.

Devaney, D. M. 1974. Shallow water asterozoans of southeastern Polynesia II. Ophiuroidea. Micronesia 10(1):105–204.

Fell, H. B. 1960. Synoptic keys to the genera of Ophiuroidea. Zool. Publs. Victoria Univ. Wellington (26):1–44, 6 figs.

———. 1961. New genera and species of Ophiuroidea from Antarctica. Trans. Roy. Soc. N.Z. 88(4):839–841, 1 text-fig.

Koehler, R. 1896. Note préliminaire sur les Ophiures recueillies pendant les campagnes de la "Princesse Alice." Mem. Soc. Zool. France 9:241–253.

———. 1906. Description des Ophiures nouvelles recueillies par le "Travailleur" et le "Talisman." Mem. Soc. Zool. France 19: 5–35, pls. 1–3.

———. 1922. Ophiurans of the Philippine Seas and adjacent waters. Bull. U.S. Natl. Mus. 100, 5:1–186, pls. 1–103.

———. 1930. Ophiures recueillis par le docteur Th. Mortensen dans les mers d'Australie et dans l'Archipel Malais. Vidensk. Medd. Naturhist. Foren. Kjobenhavn 89:1–295, 22 pls.

Ljungman, A. 1871. Förteckning öfver uti Vestindien af Dr. A. Goes samt under Korvetten Josefinas expedition i Atlantiska Oceanen smalade Ophiurider. Öfversigt K. Vet. Akad. Förh. 28(6):615–658.

Lyman, Th. 1869. Preliminary report on the Ophiuridae and Astrophytidae dredged in deep water between Cuba and the Florida reef. . . Bull. Mus. Comp. Zool. Harvard 1(10):309–354.

———. 1880. A structural feature, hitherto unknown among Echinodermata, found in deep-sea ophiurans. Anniv. Mem. Boston Soc. Nat. Hist.:1–12, pls. 1, 2.

———. 1883. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Caribbean Sea (1878–79), and on the east coast of the United States, during the summer of 1880, by the U.S. Coast Survey Steamer "BLAKE," . . .

XX.—Report on the Ophiuroidea. Bull. Mus. Comp. Zool. Harvard 10(6):227–287, pls. 1–8.

Madsen, F. J. 1970. West African Ophiuroids. Atlantide Rpt. No. 11: 151–243, text-figs. 1–49.

Matsumoto, H. 1917. A monograph of Japanese Ophiuroidea arranged according to a new classification. Jour. Coll. Sci. Imperial Univ. Tokyo 38(2):1–408, figs. 1–100, pls. 1–7.

Müller, J. and Troschel, F. H. 1842. System der Asteriden. Braunschweig, Friedrich Viewig und Sohn. xviii + 125 pp., pls. 1–12.

Schoener, A. 1967. Two new species of *Amphitarsus* (Ophiuroidea) from the western North Atlantic. Breviora No. 269: 1–9, figs. 1–3.

Thomas, L. P. 1967. The systematic position of *Amphilimna* (Echinodermata; Ophiuroidea). Proc. Biol. Soc. Washington 80:123–130, figs. 1–9.

Thomas, L. P. and Schoener, A. 1972. Growth changes in *Amphilimna olivacea* (Lyman) and the systematic status of *Amphitarsus spinifer* Schoener. Breviora No. 387: 1–9, figs. 1, 2.

Tommasi, L. 1970. Os ofiuróides recentes do Brasil e de regiões Uizinhas. Contrcões Inst. Oceanogr. Univ. São Paulo, Ser. Oceanogr. Biol. No. 20:1–146, pls. 1–46.

Verrill, A. E. 1899. North American Ophiuroidea. I. Revision of certain families and genera of West Indian ophiurans. II. A. faunal catalogue of the known species of West Indian ophiurans. Trans. Connecticut Acad. Arts. Sci. 10(7):301–385.

3

QH
1
B4X
NH

No. 15, pp. 141–158 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

AUG 27 1975
LIBRARIES

# TWO NEW SPECIES OF *BATHYCONCHOECIA* (MYODOCOPA HALOCYPRIDIDAE) FROM THE CARIBBEAN SEA

By Georgiana B. Deevey
*Florida State Museum, University of Florida*
*Gainesville, Florida 32611*

The genus *Bathyconchoecia* Deevey 1968 was established to include 6 new species of epibenthic pelagic ostracods from the Gulf of Mexico and 2 species previously assigned to the genus *Euconchoecia*. Since then 7 more species have been described (Poulsen, 1969a, 1969b, 1972; Kornicker, 1969; Angel, 1970). Members of this genus apparently live just over the bottom, in regions difficult to sample with plankton nets, and have been caught over a known depth range of 130 to 3165 m. As noted by Angel (1973), some of the species seem to be more bathypelagic than epibenthic. Poulsen (1972) has divided the known species into four more or less natural groups. *B. deeveyae* Kornicker and *B. septemspinosa* Angel differ from all other species in having long dorsal, lateral, and rostral spines, as well as a long spine at the posterodorsal corner of the right shell. *B. sagittarius* Deevey and *B. latirostris* Poulsen are distinguished by the high numbers of setae on the maxilla and the fifth and sixth limbs. A third group includes the small species less than 2 mm long, *B. paulula* Deevey, *B. laqueata* Deevey, *B. kornickeri* Deevey, *B. lacunosa* (Müller), *B. galerita* Deevey, and *B. nodosa* Poulsen, in which the shell is usually strikingly sculptured and the height of the shell is 60–70% of the length. Included in the fourth group are larger species 3.5–7 mm long: *B. baskiae* Poulsen, *B. foveolata* Deevey, *B. darcythompsoni* (Scott), *B. crosnieri* Poulsen, and *B. subrufa* Angel; in these species the height of the shell is 40–60% of the length and the

sculpturing on the shell is not as striking as in most of the smaller species.

Three specimens of *Bathyconchoecia* were found in samples collected by Dr. Harding B. Owre Michel on PILLSBURY Cruises in the Caribbean Sea. Two of these, a mature male 4 mm long and a juvenile specimen 1.25 mm long, are new species; the third specimen is considered the immature male of a species described from the Gulf of Mexico. All three specimens belong in the fourth group of larger species. The station locations in the Caribbean Sea and Gulf of Mexico where 8 species of *Bathyconchoecia* have now been found are shown in Fig. 1. I am deeply indebted to Dr. Michel for permission to examine the Caribbean samples. This work was partially supported by grant GA-36512 from the National Science Foundation.

Poulsen's (1972) key to 15 species has been changed to include the two new species. As Poulsen noted, the key is provisional since most of the species are known from only one or a few specimens, or from only one sex or a juvenile specimen. Sexual dimorphism is not marked in this genus. Aside from the male claspers on the endopodite of the second antenna and the male copulatory organ, the other differences noted may be in the relative height of the shell and in the length of the long dorsal seta on the first exopodite segment of the fifth and sixth limbs; in the known cases this is longer in the female than in the male. The present data indicate that the males are slightly larger than the females.

Male and female specimens of the same species have been described by the same author for *B. paulula*, *B. subrufa*, *B. crosnieri* and *B. darcythompsoni*. In the latter species, according to Scott (1909), the male rostrum is bifid and the female's single, so the sexes must be separated in the key. Only mature males are known of *B. laqueata*, *B. kornickeri*, *B. foveolata*, *B. baskiae* and *B. hardingae* n. sp., one of the new species here described. In the case of *B. deeveyae* the immature female (Kornicker, 1969) and the male (George, 1971) are known. Only the females of *B. galerita* and *B. latirostris*, and the juvenile females of *B. septemspinosa*, *B. lacunosa* and *B. nodosa* have been described. The other new

species now described, *B. diacantha* n. sp., is represented by a juvenile specimen.

In the case of *B. sagittarius*, my male specimen from the intestine of *Bassozetus normalis*, an abyssal bottom fish, was crumpled into a ball and part of the posterior margin of the shell was damaged, but the posterodorsal corner of the right shell seemed to be produced in a blunt point. Both Poulsen (1972) and Angel (1973) have described the female of this species, but found no point at the posterodorsal corner. There are other discrepancies. The male was characterized by a chitinous knob on the coxa of the mandible; Angel did not mention this in his description of the female, but Poulsen noted it in his. On the first antenna Angel's females had a ventral spinose seta on the segment proximal to the one bearing the cluster of sensory filaments; such a seta has not been reported for any other *Bathyconchoecia* species, although it occurs on the two new species here described. It was not noted on the male, and unfortunately the first antennae were missing from Poulsen's specimen. Also, the male had 16 setae on the 1st segment of the endopodite of the maxilla, as apparently did Poulsen's female specimen, but Angel reported 22 setae on this segment in his females. The three descriptions agree on the sculpturing on the shell and the extraordinary number of setae on the maxillae and fifth and sixth limbs, but the possibility exists that the specimens described as *B. sagittarius* may include more than one species.

KEY TO SPECIES OF *BATHYCONCHOECIA*

1. Penultimate segment of 5th limb with 7–13 setae, of 6th limb with 8–9 setae ..... 2
   Penultimate segment of 5th limb with 3–5 setae, of 6th limb with 2–3 setae ..... 3
2. Shell with dense vertical striations. Mature specimens over 2.5 mm long ..... *B. sagittarius* ♀ + ♂
   Shell with polygons or bands filled with pits; mature specimens less than 2.5 mm long ..... *B. latirostris* ♀
3. Shell with long rostral, lateral, dorsal and posterior spines ..... 4
   Shell without dorsal, lateral or rostral spines ..... 5
4. Shell surface with short fringes of fine hairs ..... *B. septemspinosa* imm. ♀
   Shell surface without fringes of fine hairs ..... *B. deeveyae* imm. ♀ + ♂

5. Posterodorsal corners of both shells with 2 small sharp points, larger on right shell ..... *B. diacantha* n. sp., juv.
   Right posterodorsal shell corner with a point or spine ..... 6
   Posterodorsal shell corners without points or spines ..... 10
6. Each half of rostrum bifid ..... *B. darcythompsoni* ♂
   Each half of rostrum single ..... 7
7. Posterior shell glands open level with edge of shell ..... 8
   Shell glands open on tubercle below posterodorsal corner of both shells ..... 9
8. Posterodorsal corner of right shell with a wide strong point; strong chitinized triangular process on coxa of mandible; penultimate segment of 5th limb with 4 setae ..... *B. hardingae* n. sp. ♂
   Posterodorsal corner of right shell with a small point; no triangular process on coxa of mandible; penultimate segment of 5th limb with 3 setae ..... *B. darcythompsoni* ♀
9. First segment of 1st antenna with large ventrodistal bulge ..... *B. crosnieri* ♀+♂
   First segment of 1st antenna without bulge ..... *B. subrufa* ♀+♂
10. Length of mature individuals over 4 mm ..... 11
    Length of mature individuals less than 4 mm ..... 12
11. Posterior shell margin fairly straight with a single row of dentate structures extending anterior to the posteroventral corner ..... *B. foveolata* ♂
    Posteroventral corner well rounded; no marginal dentate structures ..... *B. baskiae* ♂
12. Length of mature individuals less than 1 mm; height 70% of length ..... *B. paulula* ♀+♂
    Length of mature individuals 1.0–1.5 mm ..... 13
    Length of mature individuals over 1.5 mm ..... 14
13. Shell glands open on large rounded processes at posterodorsal corners of each shell ..... *B. nodosa* imm. ♀
    Posterodorsal shell corners sharply right-angled ..... *B. laqueata* ♂
14. Shell strikingly sculptured with reticulations forming polygonal cells filled with tiny pits ..... 15
    Shell not strikingly sculptured though punctate pattern may be present ..... *B. galerita* ♀
15. Flange of sculpturing on posterior margin beneath shell glands ..... *B. kornickeri* ♂
    No flange of sculpturing on posterior margin ..... *B. lacunosa* imm. ♀

**Bathyconchoecia hardingae** new species

Figures 2–4

*Holotype*: Male, 4.0 mm long by 1.6 mm high. Three slides, deposited in the National Museum of Natural History, Smithsonian Institution (USNM 152437).

FIG. 1. Station locations for species of *Bathyconchoecia* described from the Caribbean Sea and Gulf of Mexico. X 1: *B. hardingae*, n. sp.; X 2: *B. foveolata*, imm. male; X 3: *B. diacantha* n. sp. juvenile; X 4: *B. sagittarius* male, *B. foveolata* male; X 5: *B. paulula* female + male; *B. laqueata* male; *B. kornickeri* male, *B. galerita* female.

*Type-Locality*: PILLSBURY Cruise 6911, Sta. 6: 13°30'N, 62°50'W, 1324 m depth; bottom depth 1656 m. See Fig. 1: X 1.

*Etymology*: This species is named for Dr. Harding B. Owre Michel.

*Description of male*: Shell (Fig. 2a): The height of the shell is 40% of the length, anteroventral and posteroventral corners well rounded, dorsal margin nearly straight, large point at posterodorsal corner of right shell, posterodorsal corner of left shell broken off. Rostrum pointed on both shells, and projects about 20% of the shell length beyond the anterior margin. Shell gland opens beneath point on posterodorsal corner of right shell. Posterior margin of shell with a single row of dentate structures running from the shell gland and decreasing in size to anterior of the posteroventral corner. Faint scalelike sculpturing on the rostrum and anterior dorsal region, with vertical and oblique lines more visible ventrally, as shown in Fig. 2a.

First antenna (Fig. 3a): This consists of 5–6 visible segments, although Poulsen (1969a) suggested that 7 joints are represented but not clearly defined. The most distal joint bears 4 setae, the principal seta exceptionally long with fine spinules dorsally and distally, broken off as figured. The 6th segment bears a stout plumose seta. Accord-

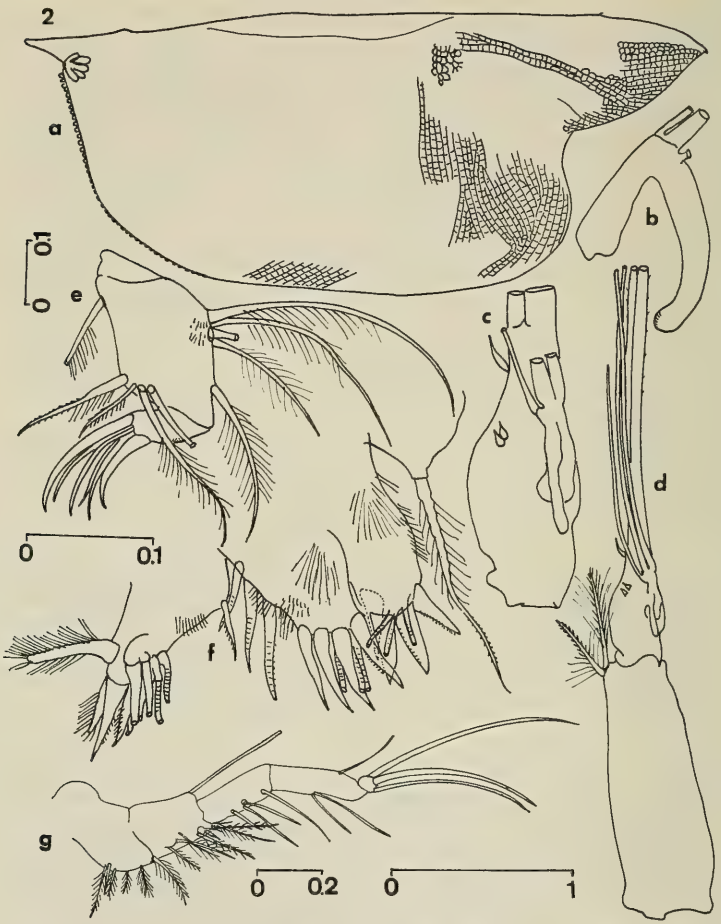



FIG. 2. Male *Bathyconchoecia hardingae*, n. sp. a, Lateral view of right shell; b, Right clasping organ; c, Distal segment of endopodite of left second antenna, setae cut off; d, Endopodite of left second antenna, longer setae cut off; e, Endopodite of maxilla; f, Coxal and precoxal endites of maxilla; g, Sixth limb. Scale for a at bottom right, for g at bottom left, for d and e on upper left margin, for c and f at left center. Scales in mm.

ing to Poulsen, the 5th segment bears the cluster of sensory filaments, which contains perhaps 15 rows of around 25 filaments per row, and there are therefore probably 300–400 filaments in the cluster. On the joint above the cluster there is a group of long hairs and a line of

shorter ones. Each first antenna has a strong seta on the ventral surface of the segment proximal to the sensory cluster, with a group of long hairs distal to it. Angel (1973) described a similar ventral seta and cluster of hairs for his female *B. sagittarius*, but such a seta has not been noted in any other species. The first 2 segments have no hairs or setae, but the 1st segment has a disto-ventral bulge. No remnant of a frontal organ was observed.

Second antenna (Fig. 2b–d): The length of the basal segment of the exopodite is around 63% of that of the shaft, the 1st segment of the endopodite around 43% of shaft length. The basal segment of the endopodite bears 2 plumose bristles distally, with long hairs proximally; the longer bristle was broken on both endopodites. The 2nd segment has distally 2 long setae with spinules at regular intervals, the longest broken at 3 mm length, the shorter 2 mm long, with a single spine proximally to their base. The right clasping organ (Fig. 2b) is large and sharply curved with 3 non-plumose setae of varying length, the longest broken at 0.8 mm, the 2nd 0.45 mm long, and the shortest only 0.25 mm long. The left clasping organ is much smaller (Fig. 2c, d) and bent back over its base, also with 3 setae of similarly varying lengths. The 2nd segment also has 2 short fat spinules near the base of the claspers.

Mandible (Fig. 3b, c; Fig. 4b): There is a strongly chitinized knob-like articular process on the coxa (Fig. 3b, c), as in *B. sagittarius* and *B. latirostris*, which has not been reported for other *Bathyconchoecia* but is common in *Conchoecia* and *Euconchoecia* species. The coxal endite has several tooth rows, with serrations of varying size; the masticatory pad consists of rows of denticles and bristling spines. The basale has 6 teeth and 2 spine-teeth. As in most other species there are 3 plumose setae on the basale near the articulation of the endopodite. The 1st segment of the endopodite has 5 setae, 1 plumose, and many fine long hairs; the 2nd segment 4 setae, and the last 6 setae and a group of long hairs near the articulation with the 2nd segment.

Maxilla (Fig. 2e, f): The endopodite (Fig. 2e) is similar to that of other species, except *B. sagittarius* and *B. latirostris*; the 1st segment has 10 plumose setae and the distal segment 2 claws and 4 setae. The precoxal endite (Fig. 2f) has 4 stout rather long bristles and 6 tubelike bristles; the coxal endite has some 14–17 bristles, including several tubelike ones.

Fifth limb (Fig. 4a): The protopodite has 3 plumose and 3 bare setae, the endopodite 3 plumose and 5 bare setae and 2 claws. The 1st segment of the exopodite has 5 plumose and 4 bare setae, as well as the long dorsal seta characteristic of this genus; it appears partially segmented at the point where the long dorsal seta arises. The 2nd segment has 4 bare setae, and the last segment 2 clawlike setae and a bare seta.

Sixth limb (Fig. 2g): The protopodite has 6 plumose setae, the 1st segment of the exopodite 6 plumose setae, 1 small bare seta, and the

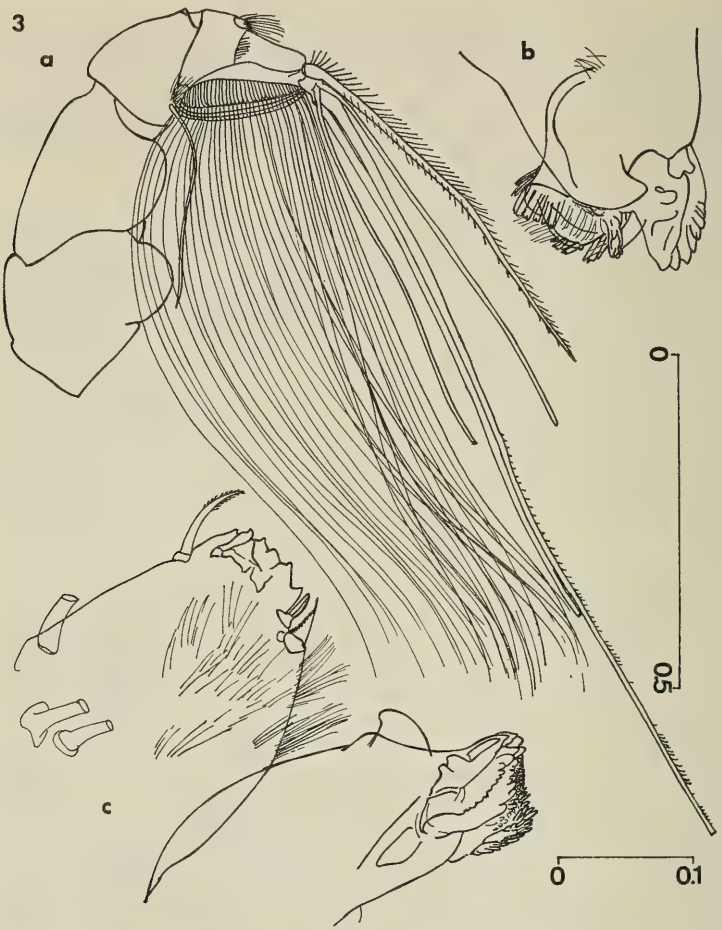



Fig. 3. *Bathyconchoecia hardingae* n. sp., male. a, First antenna; b, Incisor and molar surfaces of coxa of mandible; c, Incisor surface of basale and another view of incisor and molar surfaces of coxa of mandible. Scale on center right margin for a, at bottom right for b and c. Scales in mm.

long dorsal seta, broken on this specimen. The 2nd segment has 4 bare setae, the 3rd segment 3 bare setae, and the 4th 2 long slim clawlike setae and a bare seta.

Seventh limb (Fig. 4e): This bears distally 2 bristles, 1 at least twice as long as the other. At least near the proximal end of the larger bristle there is a very fine double comb of tiny spinules.

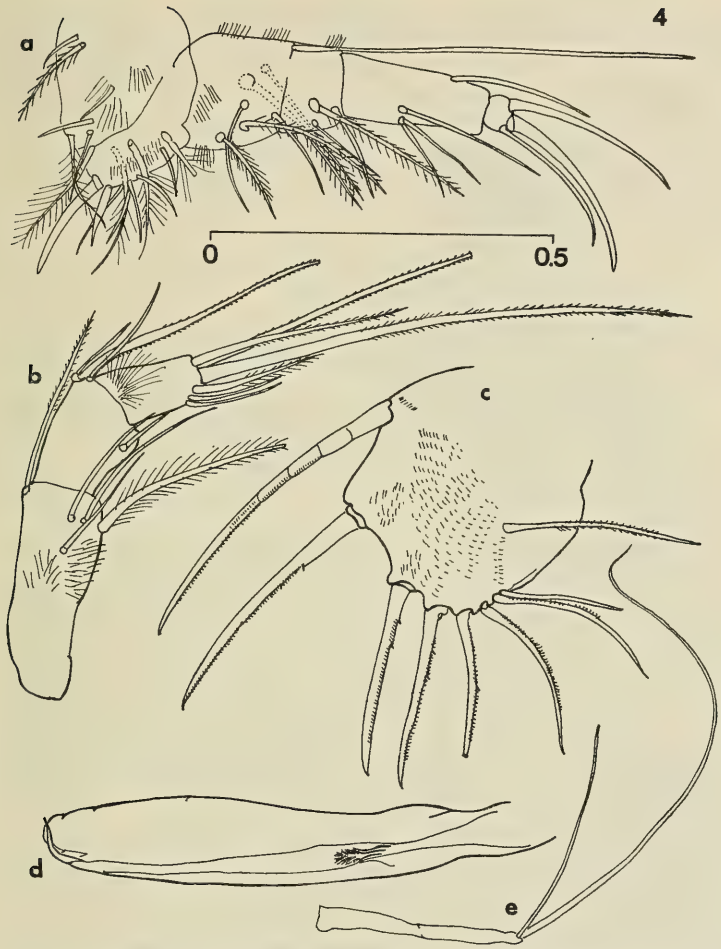



Fig. 4. *Bathyconchoecia hardingae*, n. sp., male. a, Fifth limb; b, Endopodite of mandible; c, Furca; d, Penis; e, Seventh limb. Scale in mm.

Penis (Fig. 4d): This is long, straight and slim, bluntly rounded at the tip.

Furca (Fig. 4c): As in all other described species except *B. deeveyae* there are 8 pairs of claws on this mature male. The 1st is 5-jointed, and all are very long, slim and weak. There is also a long slim unpaired bristle. The furcal lamella is partially covered with fine hairs.

*Remarks*: *B. hardingae* n. sp. differs from all other species except *B. sagittarius* and *B. latirostris* in having a highly chitinized knoblike articulation on the coxa of the mandible, but it is easily differentiated from these species by the size and shape of the shell, and by having only 3 or 4 setae on the penultimate segment of the 5th and 6th limbs. It is also distinguished from all species except Angel's (1973) female *B. sagittarius* by the long ventral seta on the segment proximal to the one bearing the large cluster of sensory filaments on the 1st antenna.

**Bathyconchoecia diacantha** new species

Figures 5–6

*Holotype*: juvenile specimen 1.25 mm long by 0.5 mm high. Two slides, deposited in the National Museum of Natural History, Smithsonian Institution (USNM 152438).

*Type locality*: Pillsbury Cruise 6811, Sta. 12: 14°50'N, 80°45'W, 1100 m depth; bottom depth 1189 m. Figure 1: × 3.

*Etymology*: The specific name is derived from the Greek "acantha," meaning spine or thorn, and refers to the 2 small points at the posterodorsal corner of both shells.

*Description*: Shell (Fig. 5a–c): The height of the shell is about 40% of the length, the anteroventral and posteroventral corners well rounded, anterior and posterior margins rounded, dorsal margin fairly straight. The rostrum is slim and pointed in lateral view, and projects 20% of the shell length beyond the anterior margin. There are 2 small sharp points at the posterodorsal corner of each shell, larger on the right shell (Fig. 5c). The shell glands are located beneath the posterodorsal points, and beneath these there is a single row of serrations or dentate structures extending to just anterior to the posteroventral corner. The sculpturing on the shell consists of faint vertical lines, as indicated in Figure 5b.

First antenna (Fig. 5d): In this juvenile specimen the penultimate segment bears the stout plumose seta and the last segment 4 setae, the principal seta the longest with a few spinules on both sides near the distal end, the total number of setae therefore being the same as in mature individuals. The cluster of sensory filaments is not as large as in the described mature specimens, possibly no more than 100 filaments being present. Only 1 of the 2 1st antennae bear ventrally on what may become the segment proximal to the sensory cluster a short seta, and distal to this a bunch of long hairs. No trace of this seta was found on the other 1st antenna. Presumably this seta is comparable to the ventral seta just described for *B. hardingae* n. sp. and Angel's female *B. sagittarius*, and it is probable that the mature individual will have a long ventral seta on each 1st antenna. No remnant of a frontal organ was noted.

Second antenna (Fig. 6e): The 1st segment of the exopodite is around 55% of shaft length, the basal segment of the endopodite about

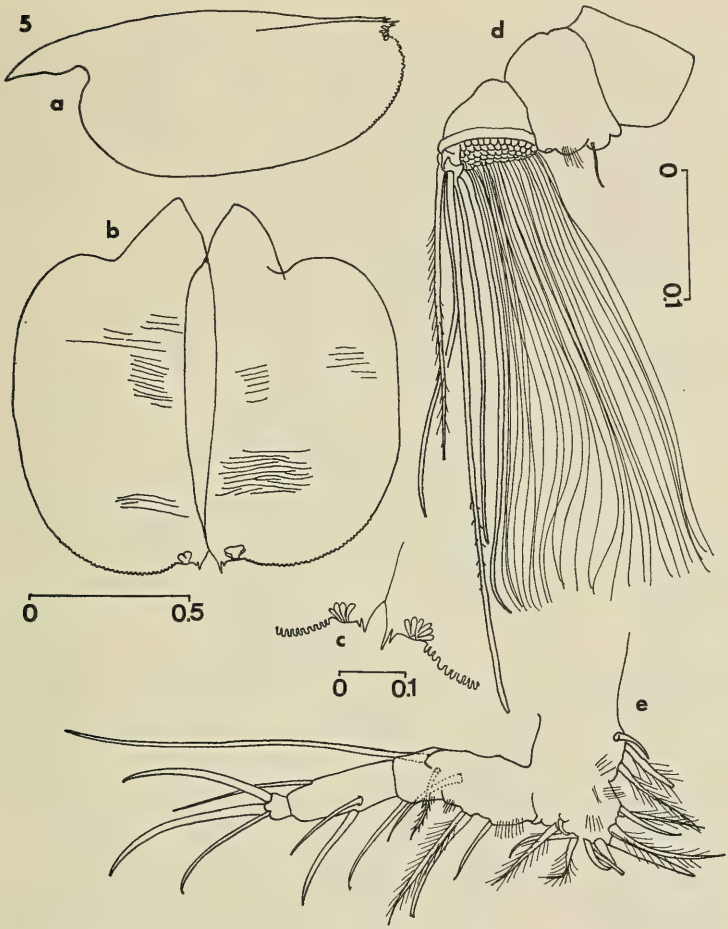



FIG. 5. *Bathyconchoecia diacantha*, n. sp., juvenile. a and b, Lateral and dorsal view of shell; c, Dorsal view of posterodorsal corner of both shells opened out; d, First antenna; e, Fifth limb. Scale below b for a and b, below c for c, at upper right for d and e. Scales in mm.

35% of shaft length. The 1st segment of the endopodite has only 1 long spinose bristle, and the 2nd segment appeared to bear only 3 setae, the longest broken, with some spinules distally.

Mandible (Fig. 6a, b): The basale has 6 teeth and 2 spine-teeth, the surface is covered with long hairs, and there are 4 long and 1 short setae, aside from 2 setae near the base of the endopodite, 1 of which is

Fig. 6. *Bathyconchoecia diacantha,* n. sp., juvenile. a, Basale with endopodite and molar and incisor surface of coxa of mandible; b, Another view of incisor surface of basale; c, Sixth limb; d, Coxal and precoxal endites of maxilla; e, Endopodite of second antenna; f, Seventh limb; g, Endopodite of maxilla; h, Furca. Scale in mm.

plumose. The endopodite has 1 seta on the 1st segment, 2 on the 2nd, and 6 spinous setae on the last segment. There is a small, strongly chitinized knoblike process on the coxa, 2 strong teeth rows, and the masticatory pad consists of rows of denticles and spinules.

Maxilla (Fig. 6d, g): The 1st segment of the endopodite has 7 plumose setae, the distal segment 2 claws and only 3 bare setae. The precoxal endite has 7 bristles, of which one has long spines and 3 are tubelike; the coxal endites have a total of 14 bristles. These are relatively long and slim in shape, as in the group of larger species.

Fifth limb (Fig. 5e): The protopodite has 2 plumose and 1 short bare seta, and is not clearly separated from the endopodite, which has 2 claws, 5 plumose and 4 bare setae. The exopodite has 2 slim claw setae on the distal segment, 3 bare setae on the 2nd segment, and 2 plumose, 4 bare setae, and the very long dorsal seta on the 1st segment. There are tufts of hairs on the protopodite, endopodite and the proximal ventral surface of the exopodite.

Sixth limb (Fig. 6c): This was segmented into only 3 distinct joints, the most distal with 2 very long slim claw-setae, the 2nd exopodite segment with 2 bare setae; the basal segment of the exopodite, not clearly separated from the protopodite, has only the long dorsal seta, broken on this specimen, and 2 setae, at least 1 plumose. The protopodite bears only 2 plumose setae and a spine. The epipodial appendage has 3 groups of 6, 5, 5 setae each.

Seventh limb (Fig. 6f): This has 2 relatively short setae, 1 much larger than the other, both bearing a row of hairs.

Furca (Fig. 6h): This has 5 claws on each lamella and a single long unpaired bristle. The 1st claw is at least 3-jointed, and there are long hairs on the lamellae.

*Remarks*: With 5 pairs of claws on the furca this specimen is 3 moults from maturity. Angel (1970) has described the juvenile development of *B. subrufa* on the basis of 11 females, 3 males and 87 juveniles at 4 different stages of development. The males were 3.48–3.515 mm and the females 3.16–3.35 mm long. This 1.25-mm juvenile is at the same stage of development as the 1.0-mm *B. subrufa* juveniles, and should therefore be around 4 mm long when mature. Angel found that the adult setation of the 1st antenna was present at this stage, but did not note whether the number of sensory filaments in the cluster changed during development. He also noted that the 1st segment of the endopodite of the 2nd antenna had 1 distal bristle at this stage, and 2 bristles were present in the last 2 juvenile stages. In *B. subrufa* the tooth lists of the mandible were similar at all stages, but the number of setae on on the basale and 1st 2 endopodite segments increased with growth; his 1.0-mm juveniles had the adult setation on the 3rd segment, as does this 1.25-mm juvenile. The number of setae on the 1st endopodite segment of the maxilla increased during development, but the distal segment had the adult setation in Angel's earliest stage; the present specimen either lacks or has lost 1 seta of the adult number on the distal segment, although it has more setae on the 1st segment than the *B. subrufa* juvenile at the same stage. The setation of the 5th and 6th limbs increases during development, but Angel found that the long

dorsal setae were present on the earliest stage examined. With the exception of *B. deeveyae* which is reported (George, 1971) to have 7, all mature *Bathyconchoecia* have 8 pairs of claws on the furca. The last 4 juvenile stages of *B. subrufa* gained 1 pair/moult. Since in *B. subrufa* the 1st claw is apparently not jointed, there are no data to indicate whether the mature *B. diacantha* n. sp. would have a 1st claw with more than 3 joints, but it is probable that it would.

This species is distinguished from all others by the 2 sharp points at the posterodorsal corners of both shells, and belongs in the group of large species. *B. diacantha* n. sp. differs from all species except *B. sagittarius*, *B. latirostris*, and *B. hardingae* n. sp. in having a knoblike articular process on the coxa of the mandible. It is also distinguished from the other species, except *B. hardingae* n. sp. and Angel's female *B. sagittarius*, by having a short (at least at this juvenile stage) seta on the ventral surface of the segment proximal to the sensory cluster on the 1st antenna.

### *Bathyconchoecia foveolata* Deevey

Figures 7–8

*Bathyconchoecia foveolata* Deevey, 1968, p. 565, Figs. 12–13.

*Material*: 1 immature male, 2.4 mm long. 3 slides.

*Locality*: Pillsbury Cruise 6911, Sta. 1: 18°00'N, 64°44'W, 1371 m depth; bottom depth 3008 m. Figure 1: × 2.

*Description of immature male*: Shell (Fig. 7a, b): The height of the shell is around 45% of the length, anteroventral and posteroventral corners rounded, dorsal and ventral margins fairly straight, posterodorsal corner bluntly rounded with shell glands opening in depression below posterodorsal corners. Rostrum rounded, projecting around 21% of the total length beyond the anterior margin. A faint pattern of reticulations was visible on the shell, and the posterior margin and at least half of the ventral margin are fringed with a single row of serrations or dentate structures, decreasing in size anteriorly (Fig. 7b).

First antenna: This was missing.

Second antenna (Fig. 7c, d): The 1st segment of the exopodite is 51% of shaft length, the 1st endopodite segment 30% of shaft length. On the distal endopodite segment the incipient clasping organs are represented by similar small knobs, each bearing 3 setae of varying lengths, all shorter than the 2 longer setae borne at the distal end, which were broken on both endopodites. At the distal end of the 1st endopodite segment there are 2 bristles, one more than twice as long as the other with long hairs proximally and spinules more distally. There are 2 small fat spinules on the distal endopodite segment beside the knoblike precursors of the claspers.

Mandible (Fig. 7e, f): The basale has a tooth row of 6 teeth and 2 spine-teeth somewhat removed from the tooth row; it has a total of 9 setae, 4 plumose, including 3 near the base of the endopodite, which

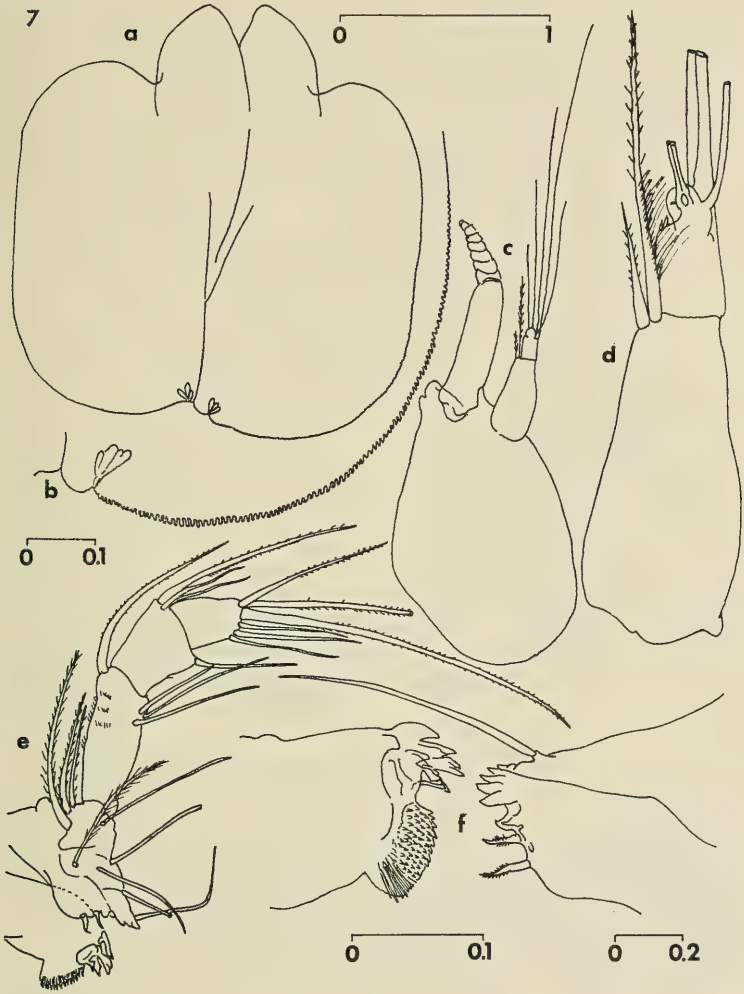



Fig. 7. *Bathyconchoecia foveolata*, immature male. a, Dorsal view of shell opened out; b, Posterior and ventral margins of shell, showing fringe of serrations; c, Right second antenna, expodite setae not shown; d, Endopodite of left second antenna, setae cut off; e, Basale and endopodite and part of coxa of mandible; f, Incisor surface of basale and incisor and molar surfaces of coxa of mandible. Scale for a at top center, for b and c at bottom right, at left center margin for e, at bottom center for d and f. Scales in mm.

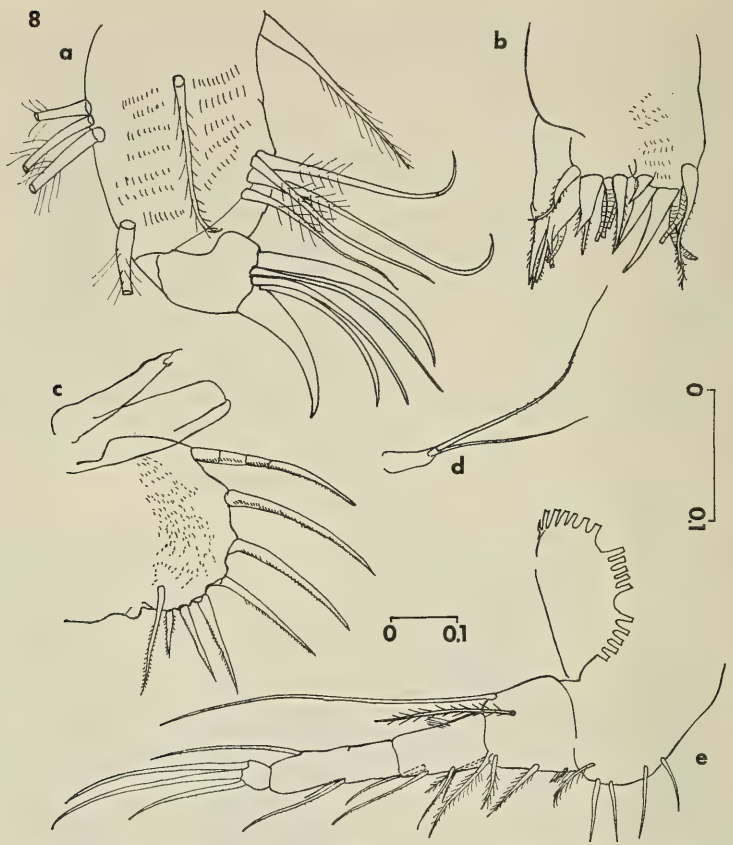



Fig. 8. *Bathyconchoecia foveolata*, immature male. a. Endopodite of maxilla; b, Coxal and precoxal endites of maxilla; c, Furca and immature penis; d, Seventh limb; e, Sixth limb. Scale for a and b at center right margin, for c, d, e at lower center. Scales in mm.

is similar to that of the *B. foveolata* male except that the 1st segment has 4 instead of 5 setae. The incisor surface of the coxa has 2 strong tooth rows with 8–9 teeth each of varying size; the molar surface is strongly rounded and covered with denticles and spines.

Maxilla (Fig. 8a, b): The precoxal and coxal endites have some 6, 7, and 6 long pointed bristles of which at least 9 are tubelike, the others spiny. The endopodite has 10 plumose setae on the basal segment; this specimen had 2 claws and only 3 bare setae on the distal segment, 1 seta longer than the other 2.

Fifth limb: This was missing.

Sixth limb (Fig. 8e): The protopodite has 5 setae; the 1st segment of the exopodite has 5 plumose setae, the long dorsal seta, and 1 small spine, the 2nd segment has 4 setae with tiny spinules, the 3rd 3 setae, and the 4th the 2 long slim claw-setae and a shorter seta with tiny spinules. The epipodial appendage has groups of 7 (1 tiny), 5, 5 setae.

Seventh limb (Fig. 8d): This has 2 setae, 1 longer with tiny spinules.

Penis and furca (Fig. 8e): The shape of the immature penis is shown in Figure 8e. The furca has 7 pairs of claws, the 1st 4-jointed, and a long unpaired bristle. The lamella is covered with fine hairs. The 1st claw of the male *B. foveolata* furca is 5-jointed.

*Remarks*: This specimen is identified as *B. foveolata* because the shape of the shell, its sculpturing and the fringe of serrations on the posterior and ventral margin agree with that of this species. Judging from the growth data obtained by Angel (1970) for *B. subrufa* a 2.4-mm immature male should be 3.5–4 mm long when mature. The described *B. foveolata* male was 5.2 mm long. The structure of the mandible appears similar to that of *B. foveolata*; the coxa also lacks the strongly chitinized process. The setation of the maxilla could be that of the immature male. The setation of the 6th limb is similar, as are the the relative lengths of the claws on the furca. This specimen has the characteristics of the group of large species: long hairs proximally on the larger bristle of the 1st segment of the endopodite of the 2nd antenna, a shell height of around 45% of its length, and coxal and precoxal endites with long slim bristles.

## Literature Cited

Angel, M. V. 1970. *Bathyconchoecia subrufa* n. sp. and *B. septemspinosa* n. sp., two new Halocyprids (Ostracods, Myodocopida) from the tropical North Atlantic and the description of the larval development of *B. subrufa*. Crustaceana 19:181–199.

———. 1973. The description of the female of the ostracod *Bathyconchoecia sagittarius* Deevey, 1968 (Myodocopida, Halocyprididae). Crustaceana 25:211–219.

Deevey, G. B. 1968. *Bathyconchoecia*, a new genus of pelagic ostracods (Myodocopa Halocyprididae) with six new species from the deeper waters of the Gulf of Mexico. Proc. Biol. Soc. Wash. 81:539–570.

George, J. 1971. On the occurrence of *Bathyconchoecia deeveyae* Kornicker (Ostracoda, Halocyprididae) in the Indian Ocean. Crustaceana 21:141–144.

Kornicker, L. S. 1969. *Bathyconchoecia deeveyae*, a highly ornamented new species of Ostracoda (Halocyprididae) from the Peru-Chile Trench System. Proc. Biol. Soc. Wash. 82:403–408.

Poulsen, E. M. 1969a. Ostracoda-Myodocopa, 1. Halocypriformes Thaumatocypridae. Dana-Report No. 75, 99 p. 40 figs.

———. 1969b. Ostracoda-Myodocopa from the eastern tropical Atlantic. Vidensk. Medd. Dansk Naturhist. Foren. Kjobenhavn 132:129–197.

———. 1972. On the *Bathyconchoecia* (Ostracoda Myodocopa) from the Azores collected by the Bathyscaph "Archimede" in 1969. Tethys 4:445–455.

Scott, T. 1909. On some new and rare Entomostraca from the Scottish Seas. Ann. Mag. Nat. Hist. Ser. 8, 3:122–130, pls. 2–4.

3

QH
1
B4X
NH

No. 16, pp. 159–166 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

AUG 27 1975
LIBRARIES

# NOTES ON MEMBERS OF THE FAMILY PORCELLANIDAE (CRUSTACEA: ANOMURA) COLLECTED ON THE EAST COAST OF MEXICO

By Jack A. Rickner
*Texas A&I University, Kingsville, Texas 78363*

In her review of the decapod crustaceans of the Gulf of Mexico, Behre (1954) stated ". . . examination of our records of the decapod Crustacea of the Gulf of Mexico indicates very clearly large gaps in our knowledge. These gaps are less evident along the northern shore and the Florida Keys than along the eastern part of Mexico and Yucatan." In the subsequent twenty years, little has been accomplished on the family Porcellanidae along the eastern coast of Mexico. Ives (1891) reported 21 decapods from Yucatán and 7 from Veracruz, but his list did not include porcellanids. Hildebrand (1954) listed only 1 porcellanid, *Porcellana sayana*, from catches by shrimp trawls on the brown shrimp grounds of the western Gulf of Mexico. Chavez, Hidalgo and Sevilla (1970) in their study of the lagoonal area of Lobos Reef listed no porcellanids among 22 species of crabs collected. My report will serve only as a preliminary survey to fill in a part of the gap in our knowledge.

## Description of Study Area

Two study areas on the East Coast of Mexico were extensively sampled during late May and June, 1973: Lobos and Enmedio Reefs; a third area, El Moro, was only briefly sampled. Lobos and Enmedio Reefs are emergent, nearshore coral reefs with small associated islands. Lobos, located 120 km southeast of Tampico (21°27′N, 97°13′W), is one of a cluster of 3 reefs which comprises the northernmost emer-

gent coral reefs in the western Gulf. It is 9.6 km offshore Cabo Rojo in 28 m of water, is approximately 2930 m long and oriented in a north-south direction (Rigby and McIntire, 1966). It is situated near the boundary between 2 faunal provinces, tropical to the south and warm-temperate to the north (Briggs, 1974:218–221).

Enmedio Reef is located 24 km southeast of Veracruz, (19°06′N, 95°56′W), 6 km off Anton Lizardo in approximately 25 m of water. It is associated with the Veracruz-Anton Lizardo Reef complex. Enmedio is approximately 1500 m long and 850 m wide at its surface, oriented in a northwest-southeast direction (Tunnell, 1974).

El Moro is an area of lava cliffs which project into the otherwise smooth, continuous sand beaches 80 km north of Veracruz (19°51′N, 96°24′W). These cliffs offer a unique habitat for many organisms which might otherwise be absent from this area.

## Material and Methods

All collections of porcellanids on Lobos (30 May–10 June) and Enmedio (14–22 June) were made during extensive daylight searches using SCUBA, a snorkel and mask, or while wading. On Lobos, the coral boulder ridge and coral spoil islands along a small boat channel which provided suitable habitats for some porcellanids were examined while wading. The lagoon, back reefs, fore reefs, and reef crests were examined using a mask and snorkel. Deeper areas of the reef were superficially sampled using SCUBA. By wading on an exposed reef crest and the coral beach during low tides, samples were taken on Enmedio. The other areas were sampled in the same manner as the corresponding areas on Lobos.

Because of poor diving conditions, El Moro was sampled only by wading in the tide pools and climbing over rock cliffs in the area of the splash zone. In this splash zone sabellarid worms, chiefly *Gunnarea* sp., had built thick mats of tubes composed of sand grains. These tubes were constructed in such a way as to leave a chambered system in which the crabs were found. Five gallons of these tubes were collected and later examined for porcellanids.

The crabs were placed in 10% formalin, labeled as to date and location, and placed in buckets for transport to the laboratory. There they were identified with the aid of papers by Haig (1956 and 1960) and several were verified by Miss Haig.

At least one specimen of each species was placed in the Texas A&I Crustacean Collection (TAIC) and several species unreported from the southwestern Gulf of Mexico were placed in the Allan Hancock Foundation Collection.

## Acknowledgments

I wish to express my thanks and sincere appreciation to Dr. J. W. Tunnell who made this project possible by furnishing transportation and most of the equipment used during this trip as well as valuable assistance. To Miss Janet Haig, Curator of Crustacea, Allan Hancock Foundation, my appreciation is given for help with the verification and identification of several specimens and review of the manuscript. For the loan of equipment during the field work I am indebted to Dr. R. B. Davis and the Caesar Kleberg Wildlife Foundation, Department of Biology, Texas A&I University. I am grateful to Lie. Rafael Vega Rivas, Director General de Regiones Pesqueras, Subsecretaria de Pesca, Secretaria de Industria y Comercio for issuing a collection permit to work in Mexico and to Ing. Graciano Bello, Pemex superintendent, Cerro Azul, for extending permission to be transported via Pemex crew boat. I also wish to express my thanks and appreciation to Dr. A. H. Chaney for his review of the manuscript and the encouragement he offered in the completion of this report.

## Account of Species

Haig (1956) listed 9 Western Atlantic genera of porcellanids. A subsequent revision (Haig, 1960) enlarged the number to 10 through the creation of *Neopisosoma* and *Clastotoechus* and the synonymizing of *Pisosoma*. Five of these genera containing 10 species were collected during this investigation. Seven of these species have not previously been reported from the southwestern Gulf of Mexico and another has been reported only from Veracruz.

*Pachycheles* Stimpson, 1858

Two species of this genus were collected, both from El Moro.

*Pachycheles ackleianus* A. Milne Edwards, 1880

*Material examined*: TAIC-380. El Moro. 1♂.

*Measurements*: Male: length 3.1 mm, width 3.8 mm.

*Remarks*: This species is known to occur in coral heads and sponges (Haig, 1956) and to a depth of 68 m (Schmitt, 1935). This individual was collected above the water level in the lower splash zone. In addition to previous records from the West Indies, Florida, and Jolbos Islands (Haig, 1956), Gore (1974) reported the species from the southwestern Caribbean and Pernambuco, Brazil.

*Pachycheles monilifer* (Dana, 1852)

*Material examined*: TAIC-379. El Moro. 1♂.

*Measurements*: Male: length 6.45 mm, width 6.55 mm.

*Remarks*: To my knowledge this is the first published record of the species in the southwestern Gulf of Mexico. Two individuals have been collected in Florida; there is a single record from Isla Contoy, Mexico, several from the Virgin Islands, Venezuela and Brazil (Haig, 1962), and one from Trinidad (Gore, 1974). This species has been taken in the littoral zone and to depths of 33 m (Haig, 1956).

*Porcellana* Lamarck, 1801

One species of this genus was collected.

*Porcellana sayana* (Leach, 1820)

*Material examined*: TAIC-429 (2). Enmedio Reef. 1♂, 1 (juv). TAIC-434. Enmedio Reef. 1♀ (ov).

*Measurements*: Male: length 7.7 mm, width 7.3 mm; ovigerous female: length 8.9 mm, width 8.2 mm; juvenile: length 4.3 mm, width 3.95 mm.

*Remarks*: One individual was taken from under coral rubble of the partly exposed lee reef crest during low tide. A second individual was taken from under a coral head in the lagoon in approximately 1.5 m of water. All were free living; however, Hildebrand (1954) found specimens attached to the decorator crab *Stenocionops furcata*, and *P. sayana* is known to be commensal with hermit crabs (Gore, 1974). This species occurs from Cape Hatteras, North Carolina to Florida, around the Gulf of Mexico and the Caribbean, south to Estado Rio Grande do Sul, Brazil (Gore, 1974). *Porcellana sayana* is known from shallow water to depths of 92 m and perhaps 713 m [?] (Gore, 1974).

*Clastotoechus* Haig, 1960

This genus contains three species; one of the two that occur in the western Atlantic is represented in this collection.

*Clastotoechus nodosus* (Streets, 1872)

*Material examined*: TAIC-381 (14). El Moro. 5♂♂, 9♀♀ (8 ov).

*Measurements*: Males: length 3.45 to 6.55 mm, width 3.0 to 6.15 mm; non-ovigerous female: length 4.8 mm, width 4.65 mm; ovigerous females: length 3.4 to 6.65 mm, width 3.1 to 6.3 mm.

*Remarks*: Previously known from St. Martin and Curaçao, Lesser Antilles, and Venezuela (Haig, 1956), its occurrence at El Moro, Mexico, extends its known range northward. Haig (1956) reported it from the littoral, among stones, and noted that it appeared to be an exceptionally small species, 2.6 mm♀, 2.5 mm♂. The individuals collected from El Moro are somewhat larger than those in previous reports.

*Neopisosoma* Haig, 1960

There are five species in this genus, with two, *N. angustifrons* (Benedict, 1901) and *N. curacaoense* (Schmitt, 1924), occurring in the western Atlantic.

*Neopisosoma angustifrons* (Benedict, 1901)

*Material examined*: TAIC-433 (18). El Moro. 2♂♂, 16♀♀ (10 ov).

*Measurements*: Males: length 2.25 and 2.45 mm, width 2.7 and 2.7 mm; non-ovigerous females: length 4.85 to 6.0 mm, width 5.0 to 6.7 mm; ovigerous females: length 2.25 to 6.15 mm, width 2.6 to 7.4 mm.

*Remarks*: This was the most abundant species found at El Moro. It has been previously recorded from islands off the coast of Venezuela and the Lesser Antilles (Haig, 1956). Its range is now extended to El Moro, Mexico. The color of the El Moro specimens ranged from light cream to a grayish blue. Both chelipeds vary in the number, 4 to 5, and shape of the carpal teeth. The shape may be bifurcate or simple. Usually the first 2 teeth are bifurcate and the last 2 teeth spinous.

*Petrolisthes* Stimpson, 1858

Five species of the genus were collected.

*Petrolisthes cessacii* (A. Milne Edwards, 1878)

*Material examined*: TAIC-373 (2). Lobos Reef. 1♂, 1♀ (ov). TAIC-374. Enmedio Reef. 1♀ (ov). TAIC-375. El Moro. 1♀ (ov).

*Measurements*: Male: length 13.7 mm, width 12.0 mm; ovigerous females: length 11.8 to 16.45 mm, width 11.95 to 16.55 mm.

*Remarks*: These are new records from the western Gulf of Mexico extending the known range to the north by 570 km. These individuals were taken from the splash zone at El Moro, from under coral rubble on the back reef crest on Lobos Reef, and from under coral rubble on Enmedio Reef in water depth of approximately 3 m. Gore (1974)

gave an account of some of the confusion in the literature concerning *P. cessacii* and *P. marginatus*. He pointed out that although *P. cessacii* from the western Atlantic was not actually reported in publication until 1970 it has probably been recorded in the literature since 1890 but incorrectly identified. Its distribution is now given as West Africa, Ascension Island, Brazil, Tobago Island, Trinidad, and the vicinity of Old Providence Island (Gore, 1974).

*Petrolisthes politus* (Gray, 1831)

*Material examined*: TAIC-376. Lobos Reef. 1♂. TAIC-377 (2). Lobos Reef. 1♂, 1♀ (ov). TAIC-378 (11). Enmedio Reef. 4♂♂, 7♀♀ (ov).

*Measurements*: Males: length 8.3 to 13.1 mm, width 8.4 to 14.1 mm; ovigerous females; length 7.0 to 9.95 mm, width 7.3 to 14.1 mm.

*Remarks*: All individuals were collected on the reef crest where coral rubble was abundant. Schmitt (1935) reported this species to a depth of 201 m. It has been reported previously from the Florida Keys, throughout the West Indies, to Panama and Veracruz, Mexico (Haig, 1956).

*Petrolisthes jugosus* (Streets, 1872)

*Material examined*: TAIC-430. Enmedio Reef. 3♂♂.

*Measurements*: Males: length 2.35 to 3.1 mm, width 2.45 to 3.2 mm.

*Remarks*: All specimens were collected from water less than 3 m deep under coral rubble. *Petrolisthes jugosus* has been reported previously from Florida, West Indies, Panama, and Venezuela (Haig, 1956) in the littoral zone, under stones and associated with *Zoanthus sociatus* and corals including *Maeandra*.

*Petrolisthes quadratus* Benedict, 1901

*Material examined*: TAIC-372 (17). Lobos Reef. 8♂♂, 9♀♀ (ov).

*Measurements*: Males: length 4.8 to 6.7 mm, width 5.0 to 6.55 mm; females: length 4.3 to 6.15 mm, width 4.5 to 6.6 mm.

*Remarks*: The individuals were taken from tide pools on a coral boulder ridge and tide pools on a coral spoil island at the edge of a dredged channel. *P. quadratus* was previously known from only a few Caribbean localities (Haig, 1962). It has been reported from the littoral zone (Haig, 1956) and from algae along the shore and rock pools (Haig, 1962; Chace and Hobbs, 1969).

*Petrolisthes galathinus* (Bosc, 1801 or 1802)

*Material examined*: TAIC-370 (15). Enmedio Reef. 8♂♂, 7♀♀ (3 ov). TAIC-371 (4). Lobos Reef. 2♂♂, 2♀♀ (ov).

*Measurements*: Males: length 6.05 to 11.4 mm, width 5.8 to 11.7

mm; non-ovigerous females: lengths 3.85 to 12.9 mm, width 3.4 to 13.0 mm; ovigerous females: length 6.65 to 8.65 mm, width 5.3 to 8.3 mm.

*Remarks*: Considerable color variation exists between the individuals collected during this study, other specimens examined from the Texas A&I Collection and the color description given by Williams (1965). In the preserved specimens from both Lobos and Enmedio Reefs, the carapace and lower surface are maroon with intervening areas of light pale blue to very light yellow. Williams (1965) reported the coloration in life as grayish brown without markings, which is in agreement with specimens collected in South Texas. The extensive range of *P. galathinus* includes the western Atlantic from Cape Hatteras, North Carolina, to Brazil, intertidally to depths of 49 m (Haig, 1962).

## Literature Cited

Behre, E. H. 1954. Decapoda of the Gulf of Mexico. *In* Gulf of Mexico, its origin, waters, and marine life. U.S. Fish Wildl. Serv. Fish. Bull. 89:451–455.

Briggs, J. C. 1974. Marine zoogeography. McGraw-Hill Book Co., New York, 475 p.

Chace, F. A., and H. H. Hobbs. 1969. The freshwater and terrestrial decapod crustaceans of the West Indies with special reference to Dominica. U.S. Natl. Mus. Bull. 292. 258 p., figs. 1–76.

Chavez, E. A., E. Hidalgo, and M. L. Sevilla. 1970. Datos acerca de las comunidades bentonicas del Arricife de Lobos, Veracruz. Rev. Soc. Mexicana Hist. Nat. 31:211–280, pls. 15, figs. 1–96.

Gore, R. H. 1974. On a small collection of Porcellanid crabs from the Caribbean Sea (Crustacea, Decapoda, Anomura). Bull. Mar. Sci. 24(3):700–721, figs. 1–5.

Haig, J. 1956. The Galatheidea (Crustacea Anomura) of the Allan Hancock Atlantic Expedition with a review of the Porcellanidae of the western North Atlantic. Rep. Allan Hancock Atlant. Exped. No. 8:1–45, pl. 1.

———. 1960. The Porcellanidae (Crustacea Anomura) of the eastern Pacific. Allan Hancock Pacif. Exped. 24:1–440, pls. 1–41.

———. 1962. Papers from Dr. Th. Mortensen's Pacific Expedition 1914–1916. 79. Porcellanid crabs from eastern and western America. Vidensk. Medd. Dansk Naturhist. Foren. 124:171–192, figs. 1–5.

Hildebrand, H. H. 1954. A study of the brown shrimp (*Penaeus aztecus* Ives) grounds in the western Gulf of Mexico. Publ. Inst. Mar. Sci. Univ. Texas 3(2):233–366, figs. 1–5.

Ives, J. E. 1891. Crustacea from the northern coast of Yucatan, the harbor of VeraCruz, the west coast of Florida and the Bermuda Islands. Proc. Acad. Nat. Sci. Philadelphia 43:176–207, pls. 1–7.

Rigby, J. K., and W. G. McIntire. 1966. The Isla de Lobos and associated reefs, Veracruz, Mexico. Brigham Young Univ., Geol. Stud. 13:1–46, pls. 1–8, text-fig. 1–9.

Schmitt, W. L. 1935. Crustacea Macrura and Anomura of Porto Rico and the Virgin Islands. Scientific Survey of Porto Rico and the Virgin Islands. New York Acad. Sci. 15(2):125–227, 80 figs.

Tunnell, J. W. 1974. Ecological and geographical distribution of Mollusca of Lobos and Enmedio coral reefs, southwestern Gulf of Mexico. Doct. Diss., Texas A&M Univ. 158 pp.

Williams, A. B. 1965. Marine decapod crustaceans of the Carolinas. Fish. Bull. U.S. Fish Wildl. Serv. 65(1):1–298, 252 figs.

73

, No. 17, pp. 167–178 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SMITHSONIAN
AUG 26 1975
LIBRARIES

# A REEVALUATION OF *PRISTINA LONGISETA* (OLIGOCHAETA: NAIDIDAE) IN NORTH AMERICA

By Walter J. Harman and Michael L. McMahan
*Department of Zoology and Physiology*
*Louisiana State University*
*Baton Rouge, Louisiana 70803*

*Pristina longiseta* Ehrenberg, 1828, long has been recognized as one of the most common aquatic oligochaetes in the world. Through the years, it has been determined to be cosmopolitan and has had several subspecies erected, usually coinciding with a continental distribution. The longest stable alliance of subspecies is: *P. longiseta longiseta* in Europe, *P. l. sinensis* in China and Africa, *P. l. leidyi* in North America, and *P. l. bidentata* in South America.

Michaelsen (1905a:309) initiated the trinominal concept by recognizing as conspecific *P. longiseta* forma *typica* from Europe and Zanzibar and *P. longiseta* var. *Leidyi* from North America and Paraguay. It was Sperber (1948:236), however, who adapted the many names into the subspecies concept as required by the International Code of Zoological Nomenclature.

In working with the Naididae, we have been impressed with the number of reports of the species in all its forms, but especially with the scarcity of morphometric data maintaining the undoubted validity of the subspecies concept. Several recent authors have raised questions regarding the validity of the subspecies, but no overt action was taken. Sperber (1948:236) said ". . . the distribution of the different forms of the *longiseta* complex indicates that they are geographical races, or perhaps even species, forming together a 'Rassenkreis,' or an 'Artenkreis.' " Brinkhurst and Jamieson (1971:

404) said ". . . it is almost impossible to separate *leidyi* from the combination of . . ." *P. l. longiseta* and *P. l. sinensis*, two subspecies which they synonymized.

Working under the subspecies concept of Western Hemisphere forms, Harman (1966:241, 1973:160) and Harman and Platt (1961:93) reported *P. l. leidyi* from several localities in North America. This was done with the idea in mind that any *P. longiseta* form in North America was automatically *leidyi*, and critical examination was foregone in the interest of expediency.

Because of modest numbers of Central American specimens at hand and because the exact point of demarcation between the ranges of *bidentata* and *leidyi* was not known, every specimen from Central America received critical examination. They all were *P. l. bidentata*. When *bidentata* also was determined to be the subspecies present in the Rio Grande region of Mexico, further interest in Texas specimens was stimulated. These also were determined to be *bidentata*. Because both *bidentata* and *leidyi* then were known to be sympatric, the prevailing concept of subspecies in the Western Hemisphere was under greater doubt. We set out to re-examine all specimens in our collection to determine where the form *leidyi*, characterized by simple-pointed needles, was to be found and how far northward the *bidentata* form, characterized by bifid needles, extended. To our great surprise and chagrin, no specimen taken in North America could be identified as *leidyi*. Critical examination of the needle setae revealed that every specimen had, in fact, a bifid needle. Therefore, the simple-pointed needle of *leidyi*, now regarded as the cardinal separatory character between *bidentata* of South America and *leidyi* of North America, did not exist. In defense of nearly a century of error, it can be stated that the bifid condition of the needle is an extremely difficult characteristic to see and that exact profile under the highest magnification using phase contrast microscopy usually is required. Even then, one is not able to see this characteristic in every setal bundle because of debris, broken setae, or the position of the mount. We now have critically re-examined every specimen available to us (nearly 600) representing more than

150 collections from 15 states in the United States and from Mexico. There is not a single specimen which does not have at least one setal bundle showing the bifid condition of the needle.

*Pristina longiseta* was described by Ehrenberg (1828:112), who characterized it as having an anterior proboscis, 7–8 uncinate setae ventrally, and three setae per bundle dorsally, longest in III. Undoubtedly, this was an adequate description at the time to separate this species from all others. Leidy (1850:44) reported a North American form which he placed in Ehrenberg's species because it corresponded to it ". . . as far as the description goes." To Ehrenberg's description, Leidy added that each worm possessed 16 segments, the ventral setae were retractile, and the dorsal setae of III were twice the length of the others.

Vejdovský (1884:31), providing the most complete description of *Pristina longiseta* among the early authors, stated that the dorsal setae all were capilliform, not noting the existence of needles.

Smith (1896:396) described *Pristina leidyi* from Illinois, stating that it probably was identical to Leidy's form of *P. longiseta*. He expressed appreciation to Vejdovský, whose familiarity with *P. longiseta* caused them to concur that the North American form was distinct from, but closely allied to, the European species. Smith, too, noted only hair setae in the dorsal bundles, but he did state that one hair in each bundle often was quite short, undoubtedly referring to the needle. Also, for the first time, serrations were seen on the hair setae. Smith saw no serrations on the proximal half of a fully-formed seta. In the middle of the hair, serrations were 6 $\mu$m apart, and the serrated condition was most evident distally.

Michaelsen (1905b:357) noted serrations on hairs of specimens from Germany and Paraguay, which he therefore identified as *P. leidyi*. Moore (1906:166) noted the absence of serrations on the hair setae of both II and III in *P. leidyi* although he did not detect the presence of needle setae. Piguet (1906:292) was the first author to observe that hair setae, with the exception of those in III, were serrated in *P.*

*longiseta*, and he was the first to note the presence of needles in the dorsal bundles of this species. The needles, 2–5 per bundle, were straight, tapering to a thin single point, and without a nodulus. Hayden (1914:137), describing a species which later was synonymized with *P. leidyi*, also observed the presence of serrated hairs, except in III, and needles in the dorsal bundles.

Michaelsen (1905a:309) placed the North American and South American forms as a variety of *P. longiseta*, i.e. *P. l.* var. *Leidyi*, and other forms were designated as *P. longiseta* f. *typica*. Chen (1940:47) compared the two forms and restored them to species rank on the basis of differences in hair serrations and the ventrals of II and III.

Černosvitov (1942:198), apparently unaware of Chen's work, described a variety of *P. longiseta* from Argentina which he named *P. longiseta*, var. *bidentata* in reference to the bifid condition of the needles. In addition to the needles, this form differed from f. *typica* in having closer serrations on the hairs and a greater difference between the teeth of ventrals of II.

Marcus (1943:107), probably not cognizant of the simultaneous work of Černosvitov, described *P. longiseta* f. *typica* from Brazil as possessing needles which were finely bifid.

Sperber (1948:236) stated that *P. longiseta* in its various forms might consist of a number of geographical races or even species, recommending that additional work must be done to clarify the status of the group. She recognized four races of the Rassenkreis *Pristina longiseta* although giving them subspecific status: *P. l. longiseta*, *P. l. sinensis*, *P. l. leidyi*, and *P. l. bidentata*.

Brinkhurst and Jamieson (1971:403) reduced the list to three subspecies by the synonymy of *P. l. sinensis* with *P. l. longiseta*. They observed that there was difficulty in separating *leidyi* from the new combination, indicating that further synonymy might be required.

We now are abolishing the subspecies concept and reporting *Pristina leidyi* Smith, 1896, to be the species name for all the forms reported from North America, South America, and Hawaii. The name is chosen because of priority held by Smith's name over that established by Černosvitov (1942:

198). This is regrettable due to the fact that the description must now include bifid needles for the species, the characteristic upon which Černosvitov's name *bidentata* was based. It here is deemed prudent to return to specific status (without subspecies) Ehrenberg's *P. longiseta* as the name for all those forms reported from Europe, Asia, and Africa. A form reported by Jackson (1931:74) from Australia cannot be identified with certainty, but it may fit better with *P. longiseta.*

It is apparent that descriptions currently found in the literature for subspecies of *Pristina longiseta* are composites of data published over a span of nearly 150 years. It is evident that, far too frequently, published data were assumed to represent fact without further investigation. The example at hand is the prevalent assumption that *P. l. leidyi* is distinguished from *P. l. bidentata* primarily by the existence of simple-pointed needles in *leidyi*, in contrast to the bifid needles of *bidentata.* Therefore, the following description of *Pristina leidyi* is based solely on our collection of this species to prevent the preservation of any erroneous information which might have been published in the past.

*Pristina leidyi* Smith, 1896, new combination

Prostomium forming a proboscis. Hair setae, 1–4 per bundle, beginning in II, serrated, except in II and III, the latter extremely elongated. Serrations up to 10 μm apart on mid-shaft, becoming closer distally. Needles, 1–4 per bundle, beginning in II, fine and straight, finely bifid, without nodulus. Ventral setae, 2–10 per bundle anteriorly, 2–12 posteriorly; in II much longer and thicker than the rest, with distal tooth twice as long as the proximal; in III, slightly longer and thicker than the rest, with distal tooth 1½ to 2 times as long as proximal; in the rest, teeth approximately equal; nodulus in II slightly proximal to median, median in III, becoming slightly distal posteriorly. Clitellum in ½VII–½X. Genital setae in VI, 1–3 per bundle, bifid, with long converging teeth, enclosed within glands. Stomach in VIII. n = 12–25. s = 13–41.

*Distribution*: North America, South America, Hawaii.

*Discussion*: From our material and from synonymy, *Pristina leidyi* is seen to be a species with considerable variability across its distribution; however, such variability is within reason for the species. The ranges of setal characteristics for all specimens from nine geographical regions within the distribution of *P. leidyi* are found in Table 1. Differences are seen in setal numbers and lengths between different

TABLE 1. Ranges of setal characteristics of *Pristina leidyi* from nine geographical areas within its distribution

| Locality | Hair Setae | | | | Needle Setae | |
|---|---|---|---|---|---|---|
| | No. per bundle (most common) | Length ($\mu$m) in III | Length ($\mu$m) exclusive of III | Serrations ($\mu$m) | No. per bundle (most common) | Length ($\mu$m) |
| Surinam (Harman, 1974) | 1–4 (1–2) | 375–750 | 142–294 | 5–1 | 1–3 | 20–75 |
| Mexico | 1–3 (1–2) | 414–450 | 133–358 | 5–2 | 1–3 (2–3) | 35–74 |
| Texas–Oklahoma | 1–3 (2–3) | 502–768 | 130–420 | 3–2 | 1–3 (2–3) | 25–88 |
| Louisiana–Mississippi | 1–4 (2–3) | 228–740 | 127–491 | 5–1 | 1–4 (2–3) | 30–93 |
| Florida–Georgia | 1–3 (2–3) | 308–992 | 151–574 | 9–2 | 1–4 (2–3) | 30–83 |
| Tennessee–Kentucky | 1–4 (2–3) | 642–829 | 163–530 | 10–3 | 1–4 (2–3) | 35–71 |
| Michigan–Minnesota | 1–3 (2–3) | 604–811 | 136–465 | 6–3 | 1–4 (2–3) | 28–64 |
| Pennsylvania–Maryland | 1–3 (2–3) | 403–681 | 148–450 | 8–1 | 1–4 (2–3) | 33–85 |
| Hawaii | 1–3 (2–3) | 616–817 | 136–343 | 3–2 | 1–3 (2–3) | 29–83 |

| Locality | Ventral Setae | | | | | |
|---|---|---|---|---|---|---|
| | No. per bundle in II | Length ($\mu$m) in II | No. per bundle in III | Length ($\mu$m) in III | No. per bundle Posterior to III | Length ($\mu$m) Posterior to III |
| Surinam (Harman, 1974) | 3–5 | 75–114 | 3–5 | 63–90 | 3–8 | 52–71 |
| Mexico | 4 | 78–86 | 4–5 | 66–77 | 2–8 | 53–70 |
| Texas–Oklahoma | 4–6 | 68–87 | 4–6 | 56–78 | 4–9 | 50–80 |
| Louisiana–Mississippi | 2–8 | 73–98 | 3–7 | 55–82 | 3–10 | 42–68 |
| Florida–Georgia | 3–10 | 67–98 | 4–9 | 55–83 | 4–12 | 48–76 |
| Tennessee–Kentucky | 5–8 | 72–83 | 5–6 | 63–72 | 4–9 | 53–68 |
| Michigan–Minnesota | 5–7 | 68–74 | 4–6 | 59–68 | 4–8 | 47–71 |
| Pennsylvania–Maryland | 4–7 | 68–96 | 4–7 | 57–80 | 4–11 | 48–66 |
| Hawaii | 4–5 | 70–84 | 4–7 | 52–62 | 4–12 | 48–60 |

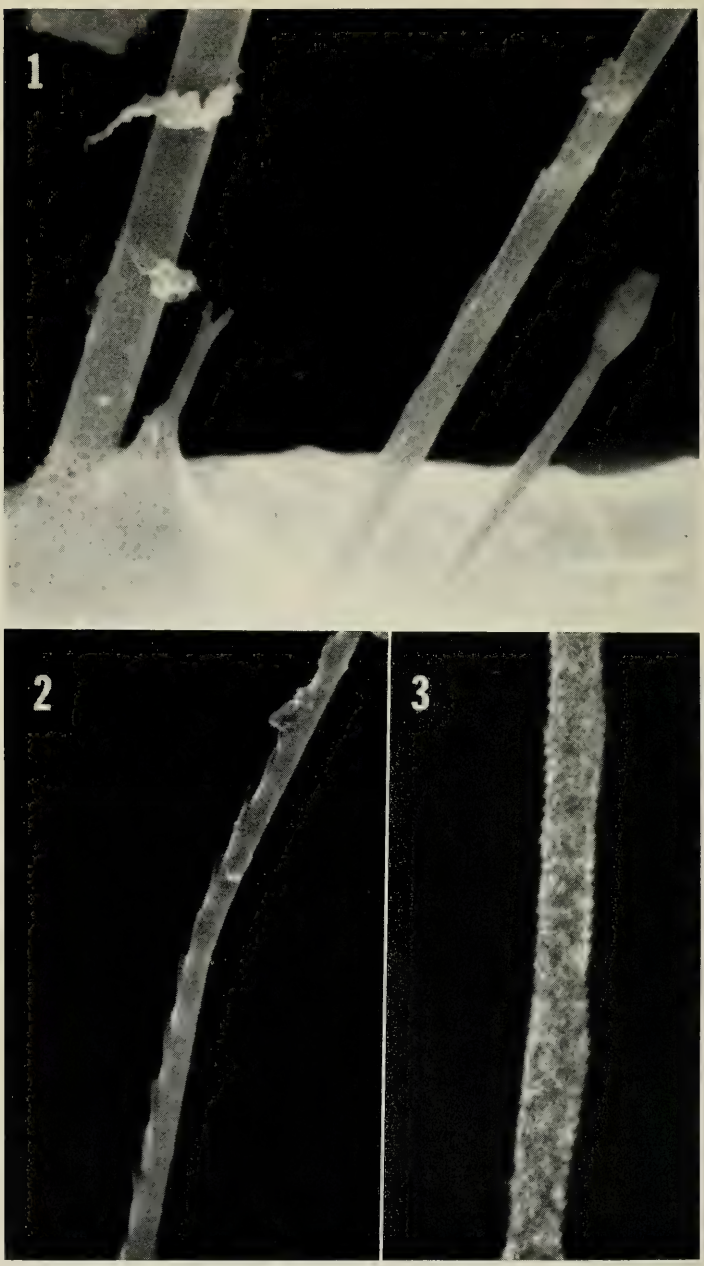
geographical areas, but such differences are slight. For instance, specimens from Mexico and Surinam characteristically usually have 1–2 hairs per bundle dorsally (in parentheses in Table 1), whereas worms from all other areas most often possess 2–3 hairs per bundle. This is a relatively minor difference, but it is one which occurs with regularity.

Characteristic of *P. longiseta* and *P. leidyi* is the presence of elongate, thickened hairs in III. In material examined in this study, the hairs of III were elongate, measuring 375–992 μm, and thickened in most cases. Occasionally, these hairs were shorter than those of other segments, especially those of mid-body, which characteristically are longest excluding those of III. Such comparatively short hairs in segment III were determined to be ones which had not developed completely and therefore had not reached their full length. The longest hair of segment III of each worm which was examined is included in the range given in Table 1; therefore, this range overlaps that of hair lengths from all other segments (127–574 μm).

Previous reports which made careful study of the hairs noted serrations (Fig. 2) on the hairs of all segments except III. This condition was first noted in *P. longiseta* (by synonymy) by Michaelsen (1905b: 357) and in *P. leidyi* by Galloway (1911:302). We must concur with Moore (1906:166), who noted the absence of serrations on the hair setae of segments II and III. After examining hundreds of specimens from throughout the Western Hemisphere, we have yet to see a serrated hair on II or III. The hairs of II often are short (125–200 μm) and covered in varying degrees with debris which might be construed to be serrations; however, critical examination at 1000 × (phase contrast) reveals that these hairs indeed are smooth, i.e. non-serrated. Scanning electron micrographs up to a magnification of 1000 × also fail to show serrations on hairs of II or III.

The teeth of the serrations in *P. leidyi* were stated by Smith (1896: 397) to be 6 μm apart in mid-seta, more evident distally, and absent proximally. Later authors extended the inter-dental distance in mid-seta to 8–16 μm in *P. leidyi* (Chen, 1940:47). Černosvitov (1942: 199) found this distance to be 3.75 μm in *P. l. bidentata.* With our synonymy of these two forms, the literature records a mid-setal inter-dental range of 3.75–16 μm, which compares favorably with our range of 3–10 μm (Table 1). An interesting and quite evident feature is that, of our material, the inter-dental distance in mid-seta is shortest, 3 μm, in specimens from Texas–Oklahoma and Hawaii (Table 1), whereas the longest such distances occur in material from areas most distant from the Texas–Oklahoma area (Tennessee–Kentucky, Florida–Georgia, and Pennsylvania–Maryland). In all cases, the serrations become more closely spaced towards the distal tip of the hair, approaching 1 μm, this being indicated by the latter figure given in the hair serrations column of the table.

It is unknown by what method earlier authors measured the distances between serrations, i.e. between what two points they measured.


1
2
3

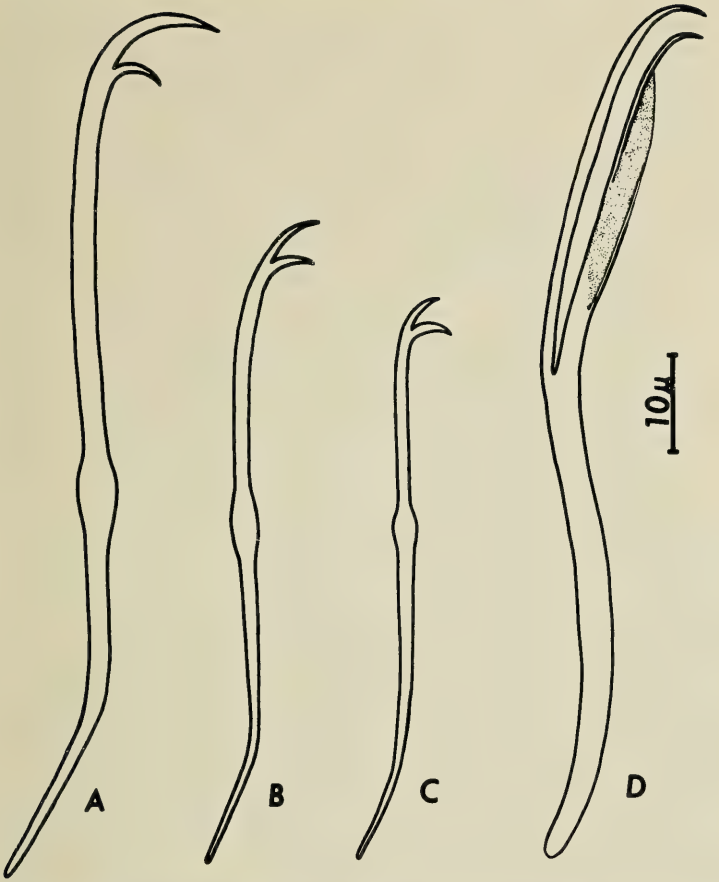



FIG. 4. Ventral setae of *Pristina leidyi*. A, ventral seta of II; B, ventral seta of III; C, posterior ventral seta; D, genital seta.

In determining these distances in our material, we determined the distance between similar portions of two adjacent serrations (tips of teeth, center of portions of serration that contact hair shaft, etc.). It is possible that some earlier authors used similar techniques, whereas others

---

←

FIGS. 1–3. Scanning electron micrographs of *Pristina leidyi*. 1, dorsal setal bundle with two needles and two hairs, × 5000; 2, hair seta near tip, × 5000; 3, hair seta of II, showing minute serrations, × 20,000.

may have measured the actual distance *between* the serrations, therefore obtaining smaller measurements.

Scanning electron microscopy at high magnifications reveals that, indeed, all hairs bear serrations. At a magnification of 20,000 diameters, serrations which are a mere 0.08 μm apart are very evident (Fig. 3). It is believed that such structures, previously undetected, represent a spiral surface modification. Because of this discovery, the statement that "hairs of II and III are unserrated" must be qualified by adding "as observed at 1000 × with phase contrast microscopy."

Černosvitov (1942:199), in his description of *P. l.*, var *bidentata*, stated that the 1–3 needles per bundle were fine, without a nodulus, and gradually tapered to the tip, which was bifid. This characteristic in itself was sufficient to distinguish his variety from any other form or variety of *P. longiseta*. The teeth were stated to be less than 0.75 μm in length, approximately equal, and spread at an obtuse angle. Marcus (1943:108) recorded a length of up to 100 μm for needles. In our material, each dorsal bundle contains 1–4 (usually 2–3) needles which measure 20–93 μm, the shorter lengths coming from segments near the ends of the worms. The teeth are approximately equal and less than 0.75 μm in our material (Fig. 1) although they may not always be apparent. More often than not the bifurcation is obscured by debris (Fig. 1) or by the position/orientation of the needle being such that the tip of the needle is seen on edge rather than in profile. In the latter case, the needle may appear to be single-pointed or to have an expanded tip. Although the teeth often are less than 0.50 μm in length, the bifurcation is evident when it is seen in good profile at magnifications as low as 400 × (phase contrast). The geometric knowledge of Černosvitov is to be suspected concerning his description of the needle bifurcation as being obtuse. In actuality, the teeth of the needles form an acute angle (Fig. 1).

Ventral setae are fewer, thicker, longer, and have longer teeth in segments II and III than in following segments. In our material, there are 2–10, usually 3–8, ventrals in the first two setigerous segments. In II, the ventrals measure 67–114 μm, and, in III, they range 52–90 μm. Posteriorly, the range is 42–80 μm, there being up to 12 setae per ventral bundle, usually 4–10. Ventrals of III (Fig. 4B) are thinner than those of II (Fig. 4A) although thicker than those of more posterior segments (Fig. 4C); however, all ventrals are of the same general shape. In II, the distal tooth is approximately two to three times the length of the proximal, lengths being 5–7 μm and 2.5–3 μm respectively. In III, the distal is about 1½ to two times the length of the proximal, and, posteriorly, the teeth become subequal, approximately 3 μm in length. Beginning in VIII, the distal tooth is distinctly thinner than the proximal (Fig. 4C). The nodulus, often weak, is slightly proximal to median in II, approximately median in III, becoming slightly distal posteriorly. All characteristics of the ventral setae, and especially those

of number and length (Table 1), are remarkably consistent throughout the distribution of *P. leidyi*.

Of nearly 600 specimens examined in the course of this study, only two individuals are clitellate, having a clitellum in ½VII–½X. Two worms, only one of which is clitellate, bear genital setae in VI, 1–3 per bundle. These setae (Fig. 4D) are greatly thickened, and the range of lengths is 80–86 μm. They are bifid, and the teeth are long, nearly equal in length, and converging at the tip. The length of the teeth is one-third to half the length of the whole seta. The proximal tooth, most dense at its edges, appears to be webbed medially due to the comparative thinness of this area. A genital gland encloses each bundle of genital setae.

Twenty-six worms, representing 4.3% of those examined, were undergoing asexual reproduction at the time of collection. The number of setigers anterior to the zone of fission varied from 12 to 25, usually 12–18. No worm had more than one budding zone. One worm which possessed a budding zone also bore genital setae in VI although it was aclitellate. Containing forty setigers, its budding zone followed XX, and it had three genital setae per bundle.

The stomachal dilatation occurs in VIII although it appears to begin in VII because it pushes septum 7/8 forward to mid-VII. It is approximately three times the diameter of the esophagus and of the anterior intestine and is nearly spherical with greatly thickened walls. Intestinal dilatation begins in IX, the diameter of this organ being greater than that of any other part of the digestive tract.

## Acknowledgments

We express appreciation to the Department of Geology, Louisiana State University, for permission to use their scanning electron microscopy facility. Mr. Mike Turner and Mr. Allen Bourland assisted with photography.

## Literature Cited

Brinkhurst, R. O., and B. G. M. Jamieson. 1971. Aquatic Oligochaeta of the World. University of Toronto Press, Toronto and Buffalo, 860 p.

Černosvitov, L. 1942. Oligochaeta from various parts of the world. Proc. Zool. Soc. London (B) 111:197–236.

Chen, Y. 1940. Taxonomy and faunal relations of the limnitic Oligochaeta of China. Cont. Biol. Lab. Soc. China 14:1–132.

Ehrenberg, C. G. 1828. Symbolae physicae –. Animalia evertebrata. Phytozoa. Berlin.

Galloway, T. W. 1911. The common fresh-water Oligochaeta of the United States. Trans. Amer. Micros. Soc. 30:285–317.

Harman, W. J. 1966. Some aquatic oligochaetes from Mississippi. Amer. Midl. Nat. 76:239–242.

———. 1973. New species of Oligochaeta (Naididae) with additional distributional records from Oklahoma and Texas. Southwest. Nat. 18:151–164.

———. 1974. The Naididae (Oligochaeta) of Surinam. Zool. Bijdr. Leiden 133:1–36.

———, AND J. H. PLATT. 1961. Notes on some aquatic oligochaetes from Louisiana. Proc. Louisiana Acad. Sci. 24:90–95.

HAYDEN, H. E. 1914. Further notes on *Pristina* and *Naidium*, with description of three new species. Trans. Amer. Micros. Soc. 33:135–138.

JACKSON, A. 1931. The Oligochaeta of south-western Australia. Jour. Proc. R. Soc. West. Australia 17:71–136.

LEIDY, J. 1850. Descriptions of some American Annelida abranchia. Jour. Acad. Nat. Sci. Philadelphia (2), 2:43–50.

MARCUS, E. 1943. Sôbre Naididae do Brasil. Bol. Fac. Fil. Ciênc. Letr. Univ. Sao Paulo, 32, Zool. 7:3–247.

MICHAELSEN, W. 1905a. Die Oligochäten Deutsch-Ostafrikas. Z. Wiss. Zool. 82:288–367.

———. 1905b. Zur Kenntnis der Naididen. *In* E. V. Daday, Untersuchungen über die Süsswasser-Mikrofauna Paraguays. Zoologica 18, 44:350–361.

MOORE, J. P. 1906. Hirudinea and Oligochaeta collected in the Great Lakes region. Bull. U.S. Bur. Fish. Washington 25: 153–171.

PIGUET, E. 1906. Observations sur les Naïdidées et revision systématique de quelques espèces de cette famille. Rev. Suisse Zool. 14:185–315.

SMITH, F. 1896. Notes on species of North American Oligochaeta. II. Bull. Illinois St. Lab. Nat. Hist., Urbana 4:396–413.

SPERBER, C. 1948. A taxonomical study of the Naididae. Zool. Bidr. Uppsala 28:1–296.

VEJDOVSKÝ, F. 1884. System und Morphologie der Oligochaeten. Prag, 172 p.

74.0673

Vol. 88, No. 18, pp. 179–188 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES
AUG 22 1975

# THE IDENTITY OF *NANNARIA CONSERVATA* CHAMBERLIN, WITH NOTES ON AN ABNORMAL MALE AND DESCRIPTIONS OF TWO NEW SPECIES OF *NANNARIA* FROM NORTH CAROLINA (DIPLOPODA: POLYDESMIDA: XYSTODESMIDAE)

By Rowland M. Shelley
*North Carolina State Museum,*
*Raleigh, North Carolina 27611*

The recent discovery of several different species of *Nannaria* in the mountains and western piedmont of North Carolina has compelled attention to the long-standing problem of *N. conservata*, whose identity has been uncertain since its original description by Chamberlin (1940). No illustrations were provided, and repeated attempts by myself to secure topotypical material from Duke Forest, Durham County, North Carolina, have been unsuccessful. This species is significant and important in the North Carolina milliped fauna because it is the easternmost *Nannaria* in the state and the only one authentically reported from a non-montane locality (Duke Forest is in the fall zone region of the eastern piedmont and over 100 miles from the Blue Ridge Front). In October 1973, I collected a male *Nannaria* from Rutherfordton, Rutherford County, in the western piedmont of the state, and could not be certain that this individual was different from Chamberlin's eastern piedmont species. Through the courtesy of Richard L. Hoffman, I have recently been able to examine the holotype of *conservata* and to determine that the Rutherford specimen is quite different indeed. This new species and one from Blowing Rock, Watauga County, North Carolina, are described herein along with comments and drawings of *conservata*, including an aberrant male with three pairs of

gonopods. This male and the holotypes of the new species are deposited in the invertebrate collection of the North Carolina State Museum (NCSM).

I am grateful to Richard L. Hoffman for the opportunity to examine the type specimen of *N. conservata* and for additional locality records of the species in North Carolina. Recent collections from Raleigh, including the abnormal, trigonopodal male, were contributed by Martha and John Cooper, N. C. State Museum. Figure 6 was prepared by Renaldo G. Kuhler, Museum staff artist; the other illustrations are the work of the author.

**Nannaria conservata** Chamberlin

Figures 1–6

*Nannaria conservata* Chamberlin, 1940:56.

*Type-specimen*: Male holotype (R. V. Chamberlin collection, now being accessioned by U. S. National Museum) collected 12 November 1939 from Duke Forest, Durham County, North Carolina, N. B. Causey, leg.

The brief original description of this species lacks illustrations and did not mention the paramedian sternal knobs between the 4th pair of legs or the pointed spur at the base of the prefemoral process, although both are noted in the description of *N. minor*, the type species (Chamberlin, 1918). The sternal knobs are subconical and subequal in length to the width of the adjacent coxae (Fig. 1). Chamberlin (1940) did state in his description that the gonopods of *conservata* "conform closely in general form to those of *N. minor*," but as can be seen from the present illustrations (Figs. 2, 3) and that by Hoffman (1964) of *minor* (which was not originally illustrated either), the gonopods of the two species are quite different. Thus, the original description of *conservata* (Chamberlin, 1940) is confusing and does not adequately depict the characters of the species. The extremely short prefemoral process was noticed by Chamberlin, however, and it is clearly the diagnostic feature of *conservata*.

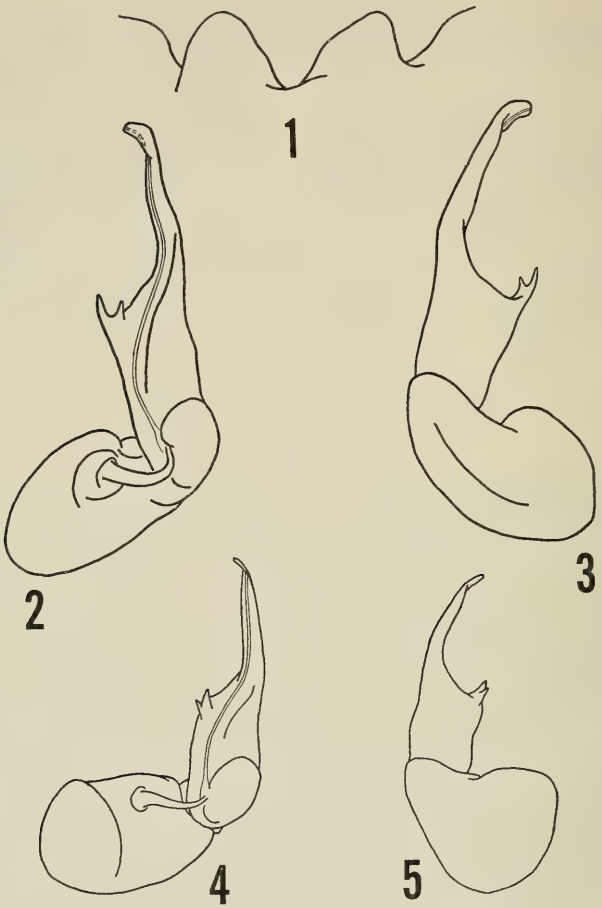
I have recently received fresh material of *conservata* from Raleigh, Wake Co., (9♂, 2♀) and submit the following observations to supplement Chamberlin's description. The species appears to be a small *Nannaria* and is considerably shorter in both length and width than the new species described later in this paper. Measurements in millimeters are given below; they were made with vernier-scale calipers with the specimens lying flat, straight, and compressed. Averages were not computed for females, since only two were available. The abnormal male, designated by an asterisk, is not included in the averages (NCSM 2829).

| | Width | Length | W/L ratio |
|---|---|---|---|
| Males | 3.1 | 16.9 | 18.3% |
| | 3.0 | 15.8 | 19.0% |
| | 3.1 | 16.1 | 19.3% |
| | 2.8 | 14.4 | 19.4% |
| | *2.9 | 14.6 | 19.9% |
| | 3.3 | 16.5 | 20.0% |
| | 3.4 | 17.0 | 20.0% |
| | 3.4 | 16.6 | 20.5% |
| | 3.3 | 15.8 | 20.9% |
| Averages | 3.2 | 16.1 | 19.7% |
| Females | 3.7 | 18.2 | 20.3% |
| | 3.3 | 15.5 | 21.3% |

In color, *conservata* is olive-brown with a pink epiproct and paranota; some individuals have a darker base color, probably due to an earlier molt. A wide pink stripe extends across the anterior edge of the collum, and, on the lighter individuals, a faint, narrow pink stripe is visible across the caudal half of each metatergum. The latter stripe is noticeably removed from the caudal edge, as opposed to most striped xystodesmids I have seen. Ventrally, they are uniformly white in color. All the specimens are fragile and easily broken or crushed.

The abnormal male possesses a condition which, to my knowledge, has not been reported before in any order of diplopods. It has a triple complement of gonopods, all located in fully formed apertures at the anterior position of segments 5, 7 (the normal location), and 9 (Fig. 6). No other external character is replicated, and the individual is normal in color pattern, although somewhat below the male average in physical dimensions (see table above). Due to the first "accessory" gonopods on segment 5, the paramedian sternal knobs of that segment are missing. The sternal spines begin as usual on the first post-gonopodal segment, but in this case it is segment 10 instead of 8. The gonopods on segments 5 and 7 are normal, but the pair on segment 9 is severely reduced in overall size, and both the telopodite and prefemoral process are incompletely developed (Figs. 4, 5). The regularity of the pattern is impressive, that segments 5, 7, and 9 are involved rather than an irregular pattern such as 5, 7, and 10 or 6, 7, and 9, etc. Unfortunately, this male was preserved before its condition was detected, and mating experiments with normal females could not be attempted, although it might be expected to be sterile. A thorough search of this locality revealed no further abnormal millipeds.

In the absence of a definitive explanation for this phenomenon, it seems best to label this male a "developmental accident," caused by




Figs. 1–5. *Nannaria conservata* Chamberlin, 1940. 1–3, holotype: 1, profile of paramedian sternal knobs between 4th pair of legs, caudal view; 2, left gonopod, medial view; 3, left gonopod, lateral view. 4–5, left gonopod of 9th segment of abnormal male (NCSM 2829): 4, medial view; 5, lateral view.

unknown genetic and/or environmental factors, and to monitor the site in future years to see if another abnormal individual appears.

*Distribution*: *Nannaria conservata* is known only from the "triangle" (Raleigh–Durham–Chapel Hill) region and nearby localities in eastern piedmont North Carolina. In addition to the type-locality, known distribution records include the following: Franklin Co., 1.5 miles SW

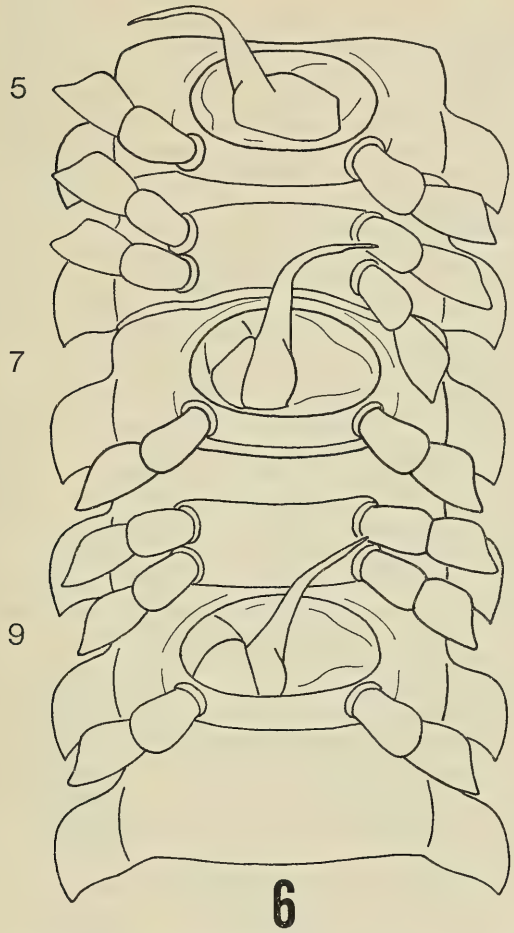



Fig. 6. Ventral view of segments 5–9 of abnormal, trigonopodal male from Raleigh (NCSM 2829). The right gonopod of seg. 5 and the left of segs. 7 and 9 were removed prior to illustration, and the remaining gonopods have been slightly displaced medially.

Pilot, 1♂ in collection of R. L. Hoffman, 2 May 1959, L. Hubricht, leg. Wake Co., Raleigh, several males and females in the Chamberlin collection, collected on two unspecified dates by unspecified collectors; and 9♂ (one abnormal with three pairs of gonopods), 2♀, NCSM 2825, 2828 and 2829, 29–31 January 1975, M. R. and J. E. Cooper, leg. I have also collected several juveniles of *Nannaria*, both sexes, from Johnston Co.,

11.1 miles SW Smithfield. These are probably *conservata*, but no adults have been encountered at this locality.

*Ecology*: No habitat descriptions have been published for *conservata*, and the type locality, Duke Forest, includes a variety of biotopes, some within the city limits of Durham. The 1975 material from Raleigh was taken from the yard of a residence in the northern part of the city. The species was concentrated primarily next to the house under a hedge and leaf clippings and was also found at the base of several trees under thick layers of pine needles. These were relatively dry locations; the milliped was not encountered in the more moist spots in the yard. The juveniles from Johnston Co. were found on sandy soil under a thin layer of leaves, in a small tract of hardwoods. This is a rather unusual habitat for xystodesmids, but *Apheloria* and *Sigmoria* were also collected there as was *Ptyoiulus*, a parajulid which I frequently find in sandy habitats.

*Remarks*: Wray (1967) included the type locality for *conservata* in his list of millipeds of North Carolina, and Brimley (1938) and Wray listed *N. minor* as having been collected in Raleigh in December and February (no year given). Since *minor* is known only from Carter Co., Tennessee, and Madison Co., North Carolina (Hoffman, 1964), these Raleigh records are undoubtedly incorrect. Additionally, there are no specimens of *minor* from Raleigh in the Chamberlin collection, but it does contain the previously mentioned specimens of *conservata*, collected on two different dates. The latter are probably what Brimley and Wray had in mind, and it seems likely that Brimley collected the millipeds and sent them to Chamberlin, who misidentified them as *minor*. The Raleigh collections of *conservata* in 1975 indicate that the species is present in the city during the winter months and further suggest that the published listings for Raleigh refer to this species and not to *minor*. Thus, *Nannaria conservata* is the only *Nannaria* so far known in the eastern piedmont region of North Carolina.

### **Nannaria rutherfordensis**, new species

Figures 7–9

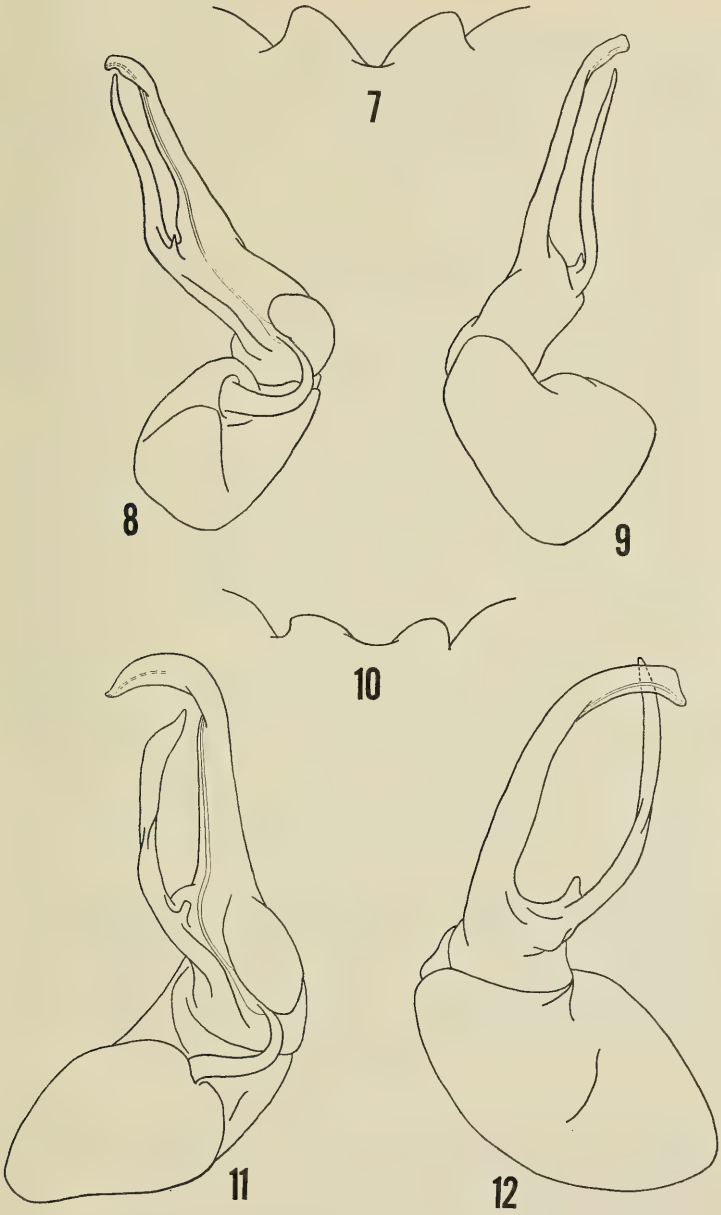
*Type-specimen*: Male holotype (NCSM 2053) collected by the author on 15 October 1973, in Rutherfordton, Rutherford County, North Caro-

---

→

Figs. 7–9. *Nannaria rutherfordensis*, n. sp. (holotype, NCSM 2053). 7, profile of paramedian sternal knobs between 4th pair of legs, caudal view; 8, left gonopod, medial view; 9, left gonopod, lateral view.

Figs. 10–12. *Nannaria domestica*, n. sp. (holotype, NCSM 1007). 10, profile of paramedian sternal knobs between 4th pair of legs, caudal view; 11, left gonopod, medial view; 12, left gonopod, lateral view.


7
8
9
10
11
12

lina, along U. S. hwy. (Business) 74, 0.2 miles W U. S. hwy. (Bypass) 74. Female unknown.

*Diagnosis*: Characterized by the following combination of characters which does not occur in any other known species of the genus: pointed spur at base of prefemoral process; prefemoral process sigmoidally curved and uniformly tapering to pointed tip, slightly shorter than acropodite; acropodite apically truncate and undivided, sharply bent mediad distally.

*Holotype*: Length 22.9 mm, greatest width 4.7 mm, W/L ratio 20.5%. Color in life unknown; coloration of preserved specimen: metaterga brown, segments 1–6 lighter than others; all terga with narrow dark stripe along posterior edge; paranota white; collum with wide white stripe along anterior edge, connecting with paranota; epicranium continuous color with anterior (lighter) segments; genal apices white; antennae light brown, distal two segments darker; venter and legs white; sterna slightly darker.

Paramedian sternal knobs between 4th pair of legs subconical, subequal in length to width of adjacent coxae (Fig. 7); sternal spines beginning as faint blunt lobes on segment 7, larger from 8–17 and becoming sharply pointed on 18 and 19; prefemoral spines short through segment 9, longer at 10 and curving caudad, longest on 17; hypoproct broadly rounded; paraprocts with margins strongly thickened.

Gonopodal aperture broadly oval, edges slightly raised and thickened; gonopods (Figs. 8, 9) with pointed spur at base of prefemoral process; prefemoral process uniformly tapering and curving sigmoidally to pointed tip, slightly shorter than acropodite; acropodite bladelike, slightly wider at midlength, bending sharply mediad distally and overlapping near tip with acropodite of opposite gonopod, apex of acropodite blunt, truncate, not apically divided.

*Ecology*: The type specimen was collected from under leaves against a log in an urban patch of hardwoods, a few feet from the pavement (elevation approximately 1000 ft.).

*Distribution*: Known only from type-locality.

*Remarks*: The prefemoral spur distinguishes this species from *N. simplex* Hoffman, 1949, and the apically blunt, distally bent telopodite distinguishes it from *N. minor* Chamberlin, 1918, and *N. fowleri* Chamberlin, 1947. The long, sigmoidally curved prefemoral process distinguishes it from *conservata*, the other known piedmont species.

**Nannaria domestica,** new species
Figures 10–12

*Type-specimen*: Male holotype (NCSM 1007) collected by the author on 16 October 1971, in Blowing Rock, Watauga County, North Carolina, from yard of residence on Goforth Road, 0.5 miles N. U. S. hwy. 321. Female unknown.

*Diagnosis*: Characterized by the strongly twisted prefemoral process with blunt spur at base; acropodite without apical division.

*Holotype*: Length 24.5 mm, greatest width 4.6 mm, W/L ratio 18.6%. Color in life unknown; coloration of preserved specimen: metaterga dark brown, with narrow dark stripe along posterior edge of segments 5–18; paranota white; collum with wide white stripe along anterior edge, connecting with paranota; epicranium brown, frons and clypeus lighter; antennae brown; venter white.

Paramedian sternal knobs between 4th pair of legs small, inconspicous, much shorter in length than width of adjacent coxae (Fig. 10); sternal spines beginning at posterior legs of segment 7, becoming spinelike on 8 and extending through 18; hypoproct with three weak lobes, one medial and one on either side; paraprocts strongly margined.

Gonopodal aperture broadly oval, edges slightly raised and thickened; gonopods (Figs. 11, 12) with blunt spur at base of prefemoral process; prefemoral process strongly twisted at midlength and curving sigmoidally posteromediad to pointed tip, shorter than acropodite; acropodite blade-like, curving strongly anteromediad distally and becoming progressively narrower to pointed tip, not apically divided.

*Ecology*: The type specimen was collected from under leaves along the edge of a paved driveway (elevation approximately 3600 ft.).

*Distribution*: Known only from type-locality.

*Remarks*: This species is very similar to *N. laminata* Hoffman, 1949. They both have twisted prefemoral processes, but *laminata* lacks the basal spur which is distinct on domestica.

## Literature Cited

Brimley, C. S. 1938. The Insects of North Carolina. North Carolina Department of Agriculture, Division of Entomology, Raleigh. 560 pp. (millipeds pp. 498–499).

Chamberlin, Ralph V. 1918. New polydesmoid diplopods from Tennessee and Mississippi. Psyche 25:122–127.

———. 1940. On some chilopods and diplopods from North Carolina. Can. Ent. 72:56–59.

Hoffman, Richard L. 1964. The status of *Fontaria pulchella* Bollman, with the proposal of a new genus and tribe in the diplopod family Xystodesmidae. Proc. Biol. Soc. Wash. 77: 25–34.

Wray, David L. 1967. Insects of North Carolina, Third Supplement. North Carolina Department of Agriculture, Division of Entomology, Raleigh. 181 pp. (millipeds pp. 150–154).

'3

8, No. 19, pp. 189–210 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES AUG 22 1975 S.I.

# THE PYCNOGONIDA TYPES OF WILLIAM A. HILTON. I. PHOXICHILIDIIDAE.

By C. Allan Child
*Department of Invertebrate Zoology (Crustacea)*
*Smithsonian Institution, Washington, D.C. 20560*

William Atwood Hilton (1878–1971) proposed 66 new species of Pycnogonida in 19 papers on the group, giving mostly preliminary descriptions based primarily on eastern and northern Pacific material. Since the few published figures are poorly drawn and all of the descriptions are inadequate and in part erroneous by today's standards, it becomes increasingly necessary to redescribe and adequately figure most of his work before further Pacific taxonomic studies can proceed. The 66 species, including two pairs named twice under different genera, are deposited in three institutions: 56 types in the U.S. National Museum of Natural History (USNM); nine in the B. P. Bishop Museum, Honolulu, Hawaii (BPBM); and one in the Pomona College Museum, Claremont, California (PCM). The state of preservation for these specimens ranges from good to disintegrated with one type known to be lost. Unfortunately, many of the USNM types were at some time squashed flat under cover glass so that, although permanent slides were never made, the specimens often appear very different from fresh material of the same species. A note on the status of the type-specimen(s) will be found in the remarks under each species.

This paper is the first of three on Hilton's material. It treats 16 proposed species. including the two twice-named pairs, in the family Phoxichilidiidae. The other two papers will describe Hilton's species of the family Ammotheidae and

finally the remaining families except the Nymphonidae. The Nymphonidae have been described adequately by Hedgpeth (1949). Descriptions of the valid species will be given as if they were being described for the first time, unless subsequent authors have described the species in works cited here, and no reliance will be given upon Hilton's original descriptions except for any applicable comments in the remarks.

Half of the species treated in this section are synonyms of previously described species while the others appear to be valid or, in one case, an indeterminable juvenile.

| Hilton's species | Present designation |
|---|---|
| *Anoplodactylus intermedius* | *Anoplodactylus batangensis* (Helfer) |
| *A. nodosus* | valid |
| *A. oculospinus* | valid |
| *A. pacificus* | valid |
| *A. projectus* | *A. portus* Calman |
| *A. robustus* | *A. portus* Calman |
| *A. unospinus* | *Phoxichilidium* sp. juvenile |
| *Phoxichilus compactus* (*Endeis compacta*) | *A. viridintestinalis* (Cole) |
| *Phoxichilidium compactum* (*Halosoma compactum*) | *A. compactus* (Hilton) |
| *P. micropalpidum* | valid |
| *P. parvum* | valid |
| *P. quadradentatum* | valid |
| *P. truncatum* | *A. robustus* (Dohrn) |
| *Pigrogromitus robustus* | *Pycnosoma strongylocentroti* Losina-Losinsky |

A complete bibliography of Hilton's pycnogonid literature is given at the end of this paper, along with other literature cited. Hilton's literature will be omitted from the second and third papers as unnecessary duplication, and they will carry only other literature cited.

I wish to thank Dr. D. M. Devaney of the Bernice P. Bishop Museum, Honolulu, Hawaii, for arranging the loan of several of Hilton's Hawaiian types.

Family *Phoxichilidiidae* Sars, 1891
Genus *Anoplodactylus* Wilson, 1878
*Anoplodactylus batangensis* (Helfer)

*Anoplodactylus intermedius* Hilton, 1942d: 44–45, fig. 2.—1942f: 73.
*Anoplodactylus batangensis*.—Stock, 1968: 54 [literature].

*Material examined*: Female, holotype: Hawaiian Islands, coll. C. H. Edmondson. BPBM 4684. Hilton includes 2 other females and 2 males in his list of specimens. These were not seen.

*Remarks*: Hilton probably did not have access to Helfer's paper when he described this species although he seems to have ignored, at times, much of the non-American literature on the group. The species is now known to have an almost pantropical distribution. The type is in poor condition.

*Anoplodactylus compactus* (Hilton)
Figure 1

*Phoxichilidium compactum* Hilton, 1939a: 27–28.—1939b: 72.—Hedgpeth, 1941: 257 [key].
*Halosoma compactum*.—Marcus, 1940: 45–46 [list].—Hilton, 1942f: 74.—Hedgpeth, 1964: 205, fig. 93b.

*Material examined*: Juvenile, holotype: Laguna Beach, southern California, intertidal, coll. Hilton, USNM 79424. Male, paratype: Pacific Grove, Monterey Bay, California, col. Hilton. USNM 80521.

*Description* (paratype): Trunk only slightly longer than wide, unsegmented. Lateral processes contiguous for over half their length. Neck short, flanked by low tubercles above insertion of ovigers. Ocular tubercle large truncated cone, without spine or papillae. Eyes large, unpigmented in alcohol. Lateral processes armed with large blunt dorsodistal tubercle, about as wide as tall, each flanked by strong anterior and posterior spine. Abdomen robust, blunt, carried almost vertically, shorter than ocular segment, not extending to tips of 4th lateral processes.

Chelifores typical of genus with few scattered setae. Chela rather large, armed with few setae. Fingers as long as palm.

Oviger 6-segmented with trace of articulation proximally on 3rd segment. Second and 3rd segments subequal. Segments 4, 5, and 6 increasingly shorter, armed with setae equal to or longer than diameter of segments, on outer margins of segments.

Legs short, robust, no segment longer than 3 times its diameter. Coxae armed with few lateral and ventrodistal setae. Coxa 2 with prominent ventrodistal tubercle only on 4th leg, bearing genital pore, armed with tuft of setae. Femur with few scattered short setae and single long seta on short dorsodistal tubercle. Femur ⅕ longer than tibiae. Femoral cement gland a very small low cup, halfway along

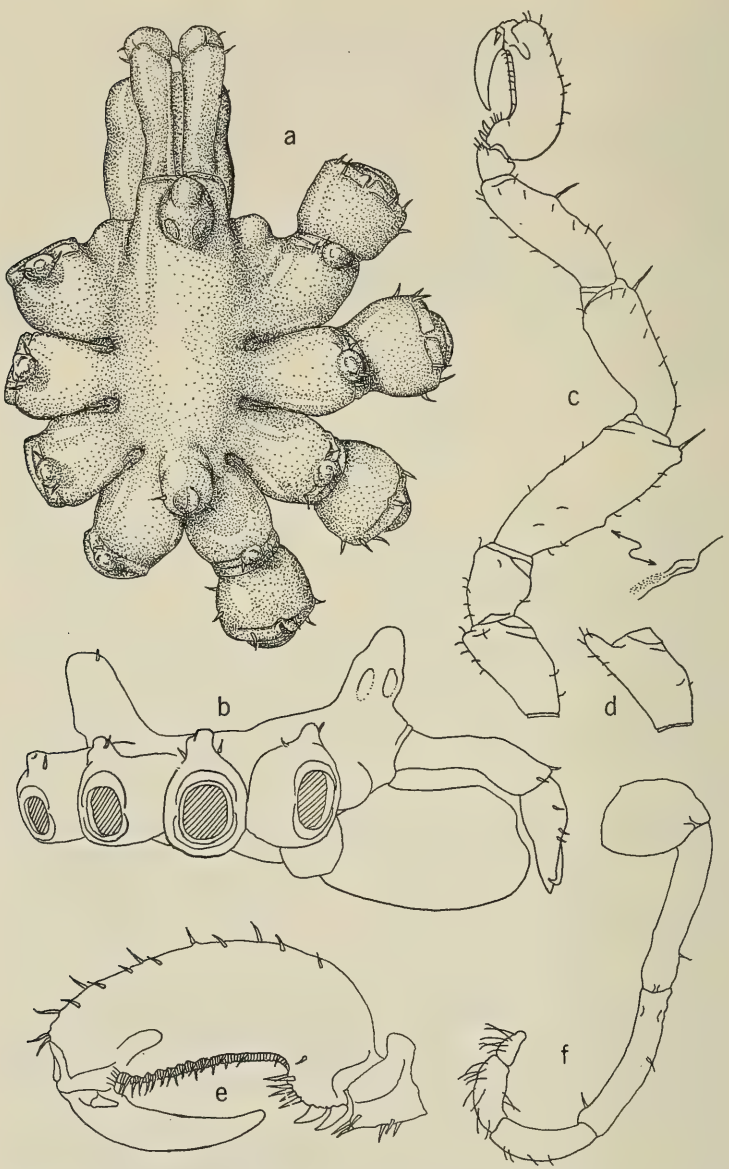



FIG. 1. *Anoplodactylus compactus*, paratype: a, Dorsal view of trunk; b, Lateral view of trunk; c, 3rd leg, femoral cement gland enlarged; d, 2nd coxa of 4th leg; e, Terminal segments of 3rd leg; f, Oviger.

segment dorsally. Tibia 1 slightly longer than tibia 2, both armed with few short dorsal and ventral setae and single long dorsal seta. Propodus with marked heel armed with 2 wide basal spines and field of 6 thin spines or setae. Sole with short spines increasing in number distally, flanking propodal lamina which extends entire length of sole. Small auxiliary claws present.

*Measurements of paratype, in mm*:

| | |
|---|---|
| Trunk length (front of ocular segment to tip 4th lateral processes) | 0.98 |
| Trunk width (across 2nd lateral processes) | .88 |
| Proboscis length (ventral) | .57 |

| Third leg: | | | |
|---|---|---|---|
| Coxa 1 | 0.30 | Tibia 1 | .59 |
| Coxa 2 | .45 | Tibia 2 | .58 |
| Coxa 3 | .30 | Tarsus | .13 |
| Femur | .72 | Propodus | .50 |
| | | Claw | .31 |

*Distribution*: Mid- and southern California coast.

*Depth range*: Intertidal, littoral.

*Remarks*: Hilton lists several specimens in his three references to this species; one from Santa Cruz Island, one from Pacific Grove, and several from Laguna Beach, one of which he named as type. His description, which is not too incorrect for this species, is based on an adult male, but for some reason he named a juvenile as the type. The holotype specimen illustrated by Hedgpeth (1964: 205, fig. 93b) shows this juvenile and does not reveal the lateral process tubercles or the propodal lamina. Unfortunately, the type has been badly damaged under a cover glass. The above redescription is based on the well preserved male paratype.

This species is superficially very much like the sympatric species, *A. viridintestinalis*. It also resembles *A. robustus* (Dohrn) (non Hilton, 1939), *A. arescus* Marcus, and other species previously synonymized under *Halosoma*. It is set apart from each of these by its prominent lateral process tubercles which make it an easily recognized species. Like others of the old *Halosoma* group, it has extremely long propodal lamina extending the length of the sole.

### *Anoplodactylus nodosus* Hilton
Figure 2

*Anoplodactylus nodosus* Hilton, 1939a: 29.—Marcus, 1940: 41 [list].—Hedgpeth, 1941: 257 [key].—Hilton, 1942f: 72.

*Material examined*: Female, holotype, USNM 14260, and Male, paratype, USNM 124014: Catalina Harbor, Catalina Island, southern California, coll. William H. Dall, January, 1874.

*Description*: Female: trunk distinctly segmented except for 3rd and 4th segments. Lateral processes separated by slightly less than their

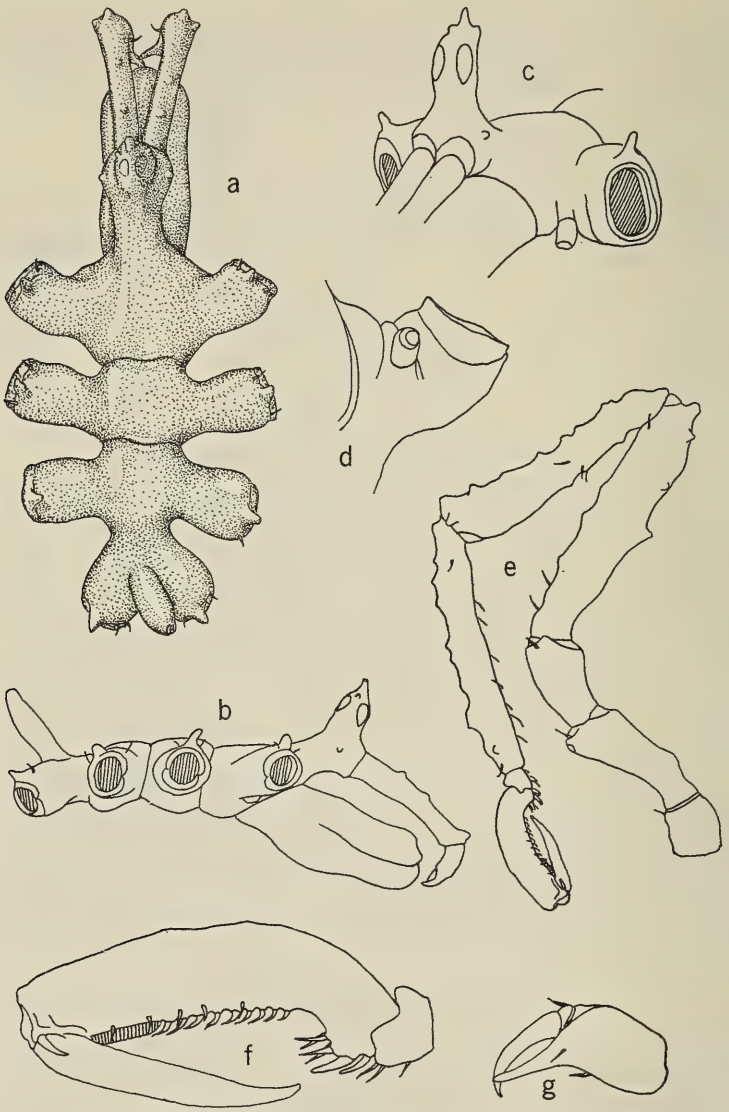



FIG. 2. *Anoplodactylus nodosus*, paratype: a, Dorsal view of trunk; b, Lateral view of trunk; c, Oblique view of trunk, anterior; d, Ventral first lateral process with oviger implantation; e, 3rd leg; f, Terminal segments of 3rd leg; g, Chela.

diameters, with thin dorsodistal tubercles flanked by single anterior and posterior setae. Ocular tubercle moderately tall, pointed, carried obliquely forward; eyes large, unpigmented, with 2 tiny (sensory?) tubercles flanking tip and 2 slightly larger tubercles flanking ocular tubercle at base. Abdomen cylindrical, glabrous, not longer than ocular tubercle, carried obliquely toward posterior, at same angle as ocular tubercle. Proboscis cylindrical, flaring at midlength.

Chelifore with scape overreaching proboscis, with 2 low tubercles along median dorsal surface and 2 dorsodistal low tubercles, glabrous. Fingers carried at slight angle to palm, overlap when closed. Palm slightly longer than fingers, armed with 3–4 short setae.

Legs of moderate length. Second coxa with raised ventrodistal tubercle bearing genital aperture, on all legs. Femur and tibiae with many small dorsal and ventral tubercles, blunt or pointed, only a few armed with seta at tip. Second tibia longest, subequal to femur. Femur and first tibia armed with several short setae laterally and ventrally. Second tibia with row of ventral short setae. Tarsus very short, with 3–4 ventral setae. Propodus long, thin, with distinct heel bearing 2 basal spines and 2 pairs of setae. Sole armed with row of curved setae flanked by several small setae. Distal propodal lamina equal to less than half sole length. Claw long, equal to length of sole. Auxiliaries present.

Male: slightly smaller than female, with female characters. Ovigers greatly reduced to single segment, as if atrophied (?). Femoral cement glands prominent on mid-dorsal surface, less than half segment diameter. Genital orifices on 2nd coxae of all available legs in same position as those of female. Propodal lamina slightly longer.

*Measurements of male, in mm*:

| | |
|---|---|
| Trunk length (anterior of ocular segment to tip of fourth lateral processes) | 2.36 |
| Trunk width (across second lateral processes) | 1.44 |
| Proboscis length (laterally) | 1.19 |

| Third leg: | | | |
|---|---|---|---|
| Coxa 1 | 0.37 | Tibia 1 | 1.6 |
| Coxa 2 | .89 | Tibia 2 | 2.02 |
| Coxa 3 | .69 | Tarsus | .16 |
| Femur | 1.97 | Propodus | .89 |
| | | Claw | .64 |

*Distribution*: Known only from the type-locality, Catalina Island, southern California.

*Depth range*: Unknown, but probably littoral or sublittoral.

*Remarks*: Hilton (1939a) listed the central California coast and islands as the distribution for this species, but never elaborated further on coastal records. It seems rather strange that this large species has never been collected since Dall's collection, but the pycnogonids of the California coast are less than perfectly known and even less perfectly recorded.

The male specimen may be aberrant, but if not, it contributes to the growing suspicion that some pycnogonids may be hermaphrodites or perhaps gynandromorphs. The ovigers do not appear to have been broken off, but instead assume a withered aspect or one of atrophy. The leg integument is thick, but the cement gland is complete and probably functional. No eggs can be seen in the male femur, nor is the female ovigerous. The male has definite genital pores on the four legs attached to the trunk, and they appear on all second coxae as with those of the female.

Hilton described the chelifores and legs as having more setae than they do. Very few of the leg tubercles have setae, but they may have broken off after many years in alcohol. These specimens are quite like *A. erectus*, particularly in the similar lateral process tubercles and propodus, but differ in the tuberculate legs. The type-specimens are in good condition except for the loss of some legs from each.

*Anoplodactylus oculospinus* Hilton
Figure 3

*Anoplodactylus oculospinus* Hilton, 1942f: 72–73.

*Material examined*: Female, holotype: Off Moss Landing, Monterey Bay, California, from rocks in 91 m, coll. E. Ricketts, no. 78.1, USNM 81494.

*Description*: Trunk fully segmented, covered with scattered tiny papillae. Lateral processes separated by slightly less than their diameter, armed with a pair of short thin tubercles distally, each bearing a seta, and a 3rd smaller tubercle, glabrous, between the 2 tubercles on the posterior 4 lateral processes. Neck widened laterally, almost to outer tips of 1st lateral processes. Ocular tubercle a large truncated cone capped with thin tubercle shorter than cone. Eyes large, unpigmented. Ocular tubercle flanked by pair of small lateral tubercles, each bearing single seta. Proboscis cylindrical, slightly bulbous proximally and flaring distally. Ventral proximal surface rough, but without tubercles. Abdomen short, curved posteriorly, reaching tips of 4th lateral processes, armed with distal seta.

Chelifores with low tubercles on dorsal and lateral surfaces of scape, each bearing short seta. Chela palm longer than fingers, armed with several endal setae. Fingers curved, crossing at tips, armed with field of setae proximally on immovable finger and 2–3 setae on movable finger.

Legs moderately long. First coxa with 2 dorsodistal thin tubercles matching those on lateral processes. Femur inflated, armed with few dorsal and lateral setae. First tibia slightly longer than second, armed with row of lateral setae and single long seta dorsodistally. Second tibia armed with rows of lateral and ventral setae and single long dorsodistal seta. Tarsus very short, armed with 2 ectal and 2 endal setae and

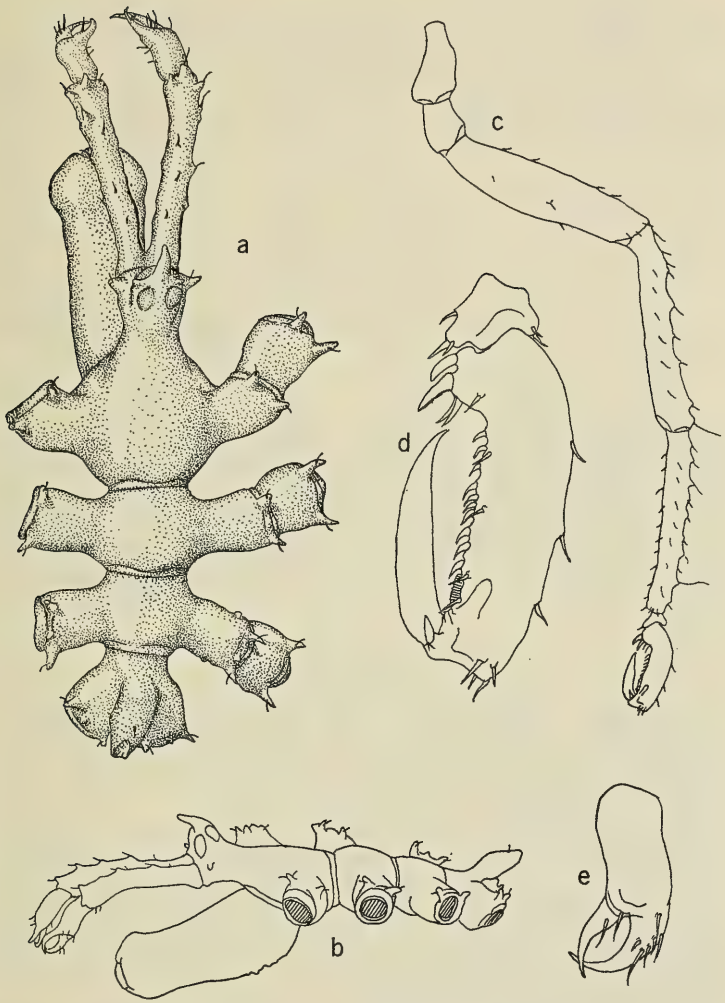



FIG. 3. *Anoplodactylus oculospinus*, holotype: a, Dorsal view of trunk; b, Lateral view of trunk; c, 3rd leg; d, Terminal segments of 3rd leg; e, Chela.

single endal spine. Propodus moderately long, with distinct heel armed with 2 curved basal spines and 2 setae. Sole with 10–11 short curved spines, flanked by 7–8 thin setae, and short propodal lamina distally. Claw robust, equal to sole length. Auxiliaries short, robust.

*Measurements, in mm*:

| | |
|---|---|
| Trunk length (anterior of ocular segment to tip fourth lateral processes) | 1.75 |
| Trunk width (across second lateral processes) | 1.0 |
| Proboscis length (laterally) | .72 |
| Abdomen length (laterally) | .28 |

| Third leg: | | | |
|---|---|---|---|
| Coxa 1 | 0.41 | Tibia 1 | 1.51 |
| Coxa 2 | .6 | Tibia 2 | 1.43 |
| Coxa 3 | .44 | Tarsus | .14 |
| Femur | 1.62 | Propodus | .71 |
| | | Claw | .44 |

*Distribution*: Known only from its type-locality, Moss Landing, California.

*Depth range*: 91 m.

*Remarks*: Although described from a single female specimen that remains unique in spite of an active marine laboratory situated at its collecting site, this species is valid. The specimen is similar to *A. nodosus*, except for the double tubercles on the lateral processes and first coxae. The legs and scape are equally nodose, but the proboscis, chela and propodus are quite different in shape. The specimen is also about ⅓ smaller than *A. nodosus*. It is well preserved, although missing three legs.

### *Anoplodactylus pacificus* Hilton

Figure 4

*Anoplodactylus pacificus* Hilton, 1942f: 73.—Stock, 1955: 242–243.

*Material examined*: Male, holotype: Dakins Cove off Avalon, Santa Catalina Island, southern California, Blake trawl in 86 m, coll. Albatross, 8 April 1896, sta. 3662. USNM 77078.

*Description*: Trunk slender, segmented except for last 2 segments. Lateral processes long, smooth, separated by more than their diameter, armed distally with pair of dorsal setae. Neck long, posterior slightly raised above 1st trunk segment. Ocular tubercle large, conical, pointing toward anterior (tip broken off). Eyes large, slightly pigmented. First lateral processes with small tubercle above oviger implantation. Abdomen thin, vertical, armed with distal seta.

Proboscis cylindrical, curved dorsally, inflated at midlength. Mouth truncated, lips distinct.

Chelifores slender. Scape with row of dorsal setae and small tubercle at dorsodistal margin. Chela palm rectangular, with 2–3 dorsal setae. Fingers thin, as long as palm, curved, crossing at tips, armed with 8–9 dorsal and lateral setae on movable finger and single seta on immovable finger. Without teeth or spines.

Oviger thin, with 6 segments. Second segment 9 times its diameter, half as long as 3rd segment. Fourth and 5th segments subequal, half

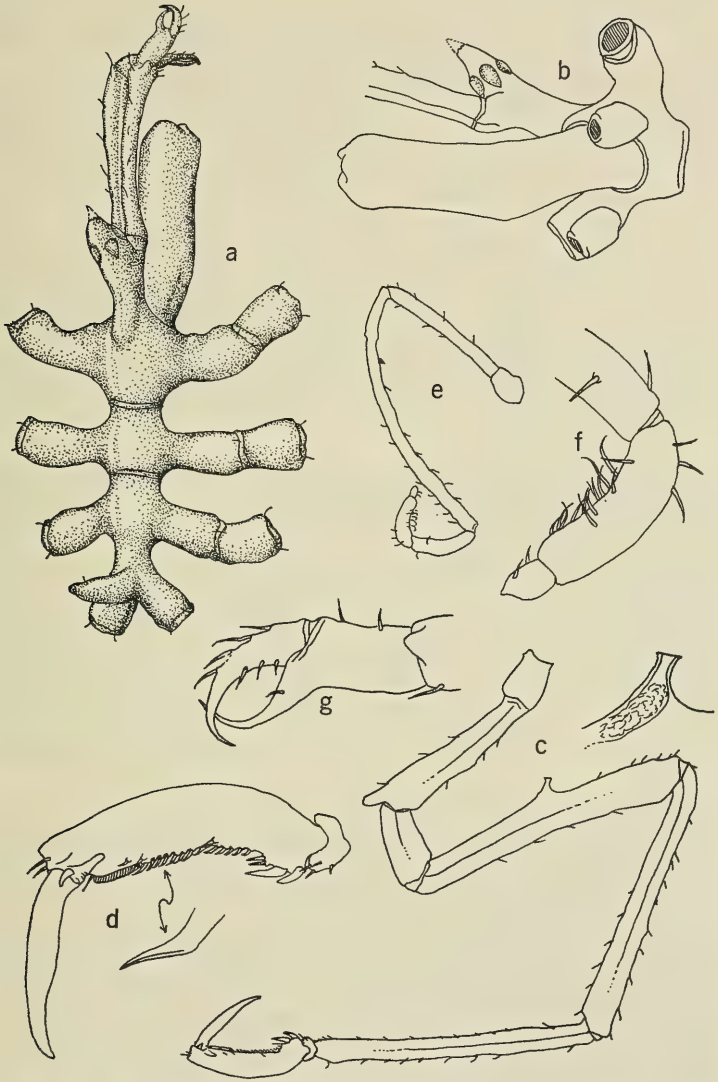



FIG. 4. *Anoplodactylus pacificus*, holotype: a, Dorsal view of trunk; b, Ventral oblique view of trunk anterior; c, 3rd leg, with enlargement of femoral cement gland; d, Terminal segments of 3rd leg, with enlargement of sole spine; e, Oviger; f, Oviger terminal segments; g, Chela.

as long as 2nd segment. Sixth segment ovoid, slightly longer than wide. All segments with few endal and ectal setae; 5th segment with field of endal setae, 6th with 2 endal setae.

Legs slender, lateral moult sutures distinct proximally on longer segments. Coxa 2 with low mid-dorsal elevation and short ventrodistal tubercle. Femur longest segment, without distal tubercle or long seta. Femoral cement gland on mid-dorsal surface, the raised duct about half segment diameter, broad at base, flaring at tip. Tibia 1 and 2 slightly shorter than femur, without distal tubercles or long setae. Coxa 2, femur, and tibiae armed with short dorsal and ventral setae. Tarsus extremely short, merely a semicircle, armed with 3–4 short ventral setae. Propodus long, thin, without marked heel. Two curved spines and pair of setae on heel, 14–15 sole spines, bent anteriorly and slightly concave on outer surface, flanked by several lateral setae. Propodal lamina less than ⅓ sole length. Claw thin, ⅔ propodal length. Auxiliary claws minute.

*Measurements, in mm*:

| | |
|---|---|
| Trunk length (chelifore insertion to tip fourth lateral processes) | 2.68 |
| Trunk width (across first lateral processes) | 1.92 |
| Proboscis length (ventrally) | 1.95 |
| Abdomen length (laterally) | .48 |

| Third leg: | | | |
|---|---|---|---|
| Coxa 1 | .48 | Tibia 1 | 2.77 |
| Coxa 2 | 1.86 | Tibia 2 | 2.68 |
| Coxa 3 | .87 | Tarsus | .27 |
| Femur | 2.82 | Propodus | 1.12 |
| | | Claw | .76 |

*Distribution*: Known only from Santa Catalina Island, southern California.

*Depth range*: 86 m.

*Remarks*: Hilton incorrectly published the type-locality as Albatross station 4424, which is nearby, but labels with the type specimen give the locality and station number as shown above.

Stock (1955: 242–243) compared this species with a very closely related species, *A. erectus*. The comparisons were correct except for the following two. The propodal sole spines are bent and concave on their ectal surface, but are not denticulate. The oviger segments are thin, but the 2nd segment is only 9 times its diameter, instead of 12 times as long.

This species probably exists in several California collections as *A. erectus*, and has remained unrecognized because of Hilton's sketchy preliminary description. Hilton (1942f: 73) listed "lateral spines and terminal spines on the ocular tubercle." The lateral spines are missing and I can find no evidence of their ever having been present. The ocular tubercle spines (setae?) are missing because the tubercle tip

has been broken off at some time. Verification must await recognition of this species in other collections.

*Anoplodactylus pacificus* bears a superficial resemblance to *A. gestiens* in its long and widely spaced lateral processes, long neck and thin chelifores, and two heel spines on the thin propodus. It differs immediately from *A. gestiens*, in not having chela finger teeth, a straight cylindrical proboscis, and a low ocular tubercle.

The type-specimen is well preserved, but missing some legs.

### *Anoplodactylus portus* Calman

*Anoplodactylus portus* Calman, 1927: 405–408, fig. 103.—Stock, 1955: 238–239 [literature].

*Anoplodactylus robustus* Hilton, 1939a: 28–29 [non *A. robustus* (Dohrn, 1881)].—Hilton, 1942b: 288–291, pl. 39.—Hilton, 1942f: 72.—Hedgpeth, 1941: 257 [key].

*Anoplodactylus projectus* Hilton, 1942d: 45–47, fig. 3.—Hilton, 1942f: 73.

*Material examined*: *Anoplodactylus robustus*, male and female, syntypes: Laguna Beach, southern California, coll. W. A. Hilton. USNM 79416.

*Remarks*: Hilton's well preserved specimens of *A. robustus* agree in all particulars with Calman's figure 103 except that the female dorsodistal tubercle on the femur is slightly smaller, and are clearly Calman's species as Stock (1955) points out. The female Hawaiian specimen of *A. projectus* was not seen, but was examined and synonymized by Stock for a work on Hawaiian pycnogonids soon to be published (Stock, in press).

### *Anoplodactylus robustus* (Dohrn)

*Phoxichilidium truncatum* Hilton, 1942d: 48–49, fig. 5.—Hilton, 1942f: 71.—Stock, [in press].

*Anoplodactylus robustus*.—Stock, 1955: [literature].

*Material examined*: Male, holotype: Oahu, Hawaiian Islands, coll. C. H. Edmondson?. BPBM 4691.

*Remarks*: Close examination of Hilton's broken up specimen reveals it to be *A. robustus*. Hilton listed a 6-segmented oviger, but may have confused the 3rd segment constriction with a segmentation line. Both ovigers are broken off at either the base or second segment and are missing. Hilton also described the propodus as having three heel spines, but all legs available have two propodal heel spines with a single seta distal to the spines. The specimen has been squashed under cover glass at some time. Hilton listed five other specimens in the type lot and another from Kawailoa, a beach on NW Oahu Island. None of these specimens were examined.

*Anoplodactylus viridintestinalis* (Cole)

*Phoxichilus compactus* Hilton, 1939a: 35.—Hedgpeth, 1941: 254 [key].
*Endeis compacta* Hilton, 1943b: 19.—Hedgpeth, 1952: 430.
*Anoplodactylus viridintestinalis*.—Stock, 1955: 239 [literature].

*Material examined*: Female, holotype: Dillon Beach, Marin County, California, on bryozoans, coll. O. Hartman, 20 December 1934. USNM 81529.

*Remarks*: Hilton was confused about this specimen. In 1939 he described it as *Phoxichilus compactus*, new species, and again in 1943 described it as another new species, *Endeis compacta*. The specimen was to be deposited in the USNM collections in 1939, but was withheld until after he had redescribed it in 1943. The single specimen is badly damaged, with the ocular tubercle and chelifores lacking. The remainder of the specimen conforms exactly with *A. viridintestinalis*. Hedgpeth (1952) was the first to recognize the specimen for what it is. It comes from Cole's type-locality.

*Phoxichilidium micropalpidum* Hilton
Figure 5

*Phoxichilidium micropalpidum* Hilton, 1942f: 72.—Hedgpeth, 1949: 283 [text].

*Material examined*: Male, holotype: Off Cape Monati, Bering Island, Commander Islands, Russian Arctic, 54°36′15″N., 166°57′15″E., 132 m, coll. Albatross, sta. 4792, 14 June 1906. USNM 81522.

*Description*: Trunk completely segmented, lateral processes separated by slightly less than their diameter, without tubercles, armed distally with 1–2 setae on anterior and posterior surfaces. Ocular segment with 2–3 setae laterally just posterior to chelifore insertion. Eye tubercle cylindrical with conical apex. Eyes slightly pigmented. Proboscis cylindrical, half trunk length, slightly constricted behind mouth, oral surface convex. Abdomen small, glabrous, blunt at tip.

Scape downcurved, finely pilose distally, armed with few short setae dorsodistally. Chela of moderate size, fingers overlap when closed, palm with many fine setae distally, fringe of fine setae on ectal surface of movable finger. Fingers without teeth.

Palp a small bud anterior to and above oviger insertion.

Oviger 5-segmented, 3rd segment longest, constricted near proximal end, with scattered ectal and endal setae. Second and 5th segments equal, setose distally. Fifth segment with linear ectal, lateral, and endal setae, mostly recurved, terminal segment slightly spatulate.

Third leg long, surfaces pilose with tiny setae. First coxa slightly over half length of 3rd. Second coxa longer than 1st and 3rd together, with low dorsal swelling toward proximal end and larger ventrodistal swelling with genital pore. Femur with 4–5 low tiny ventral tubercles,

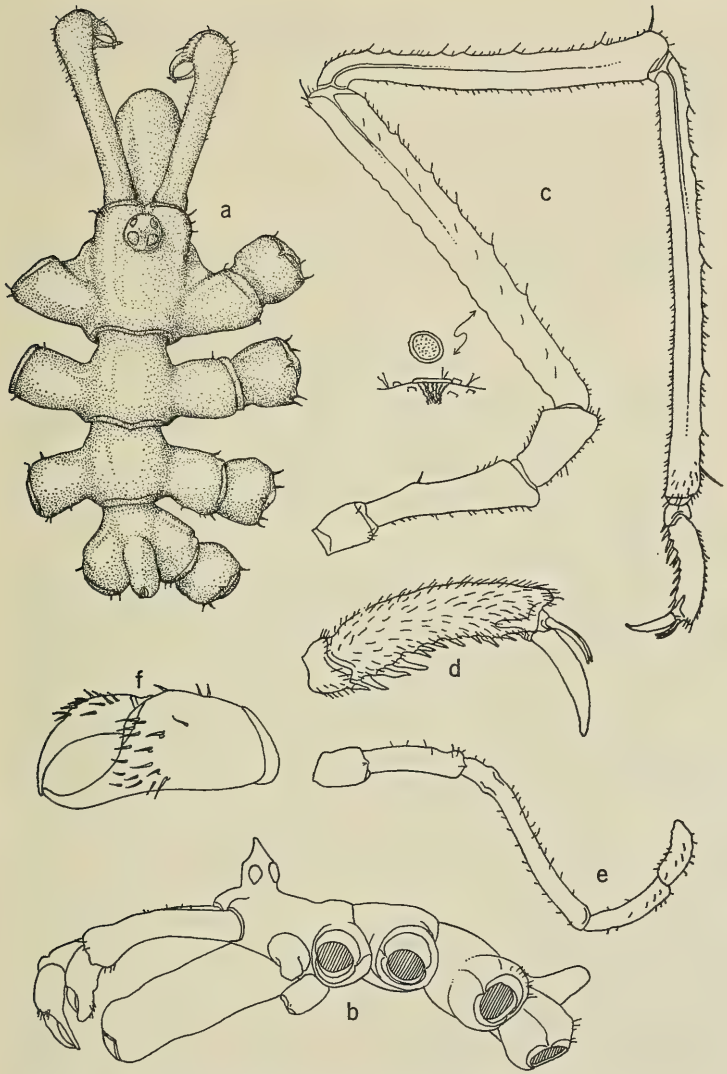



FIG. 5. *Phoxichilidium micropalpidum*, holotype: a, Dorsal view of trunk; b, Lateral view of trunk; c, 3rd leg, with enlargement of one femoral cement gland; d, Terminal segments of 3rd leg; e, Oviger; f, Chela.

each bearing a short seta. Femoral cement glands a single row of 18 cribriform discs on almost entire dorsal length of femur. Tibiae with 7–8 low tiny dorsal tubercles with single short setae. Tibia 2 one-fourth longer than tibia 1. Terminal segments small; tarsus short, with single ventral spine. Propodus slightly curved, armed with 3 heel spines and 9–10 shorter sole spines, entire surface finely pilose. Claw moderately long, auxiliaries slightly less than half main claw length.

*Measurements, in mm*:

| | |
|---|---|
| Trunk length (chelifore insertion to tip fourth lateral processes) | 4.08 |
| Trunk width (across first lateral processes) | 2.77 |
| Proboscis length (laterally) | 2.04 |
| Abdomen length (laterally) | .5 |

| Third leg: | | | |
|---|---|---|---|
| Coxa 1 | 0.78 | Tibia 1 | 5.06 |
| Coxa 2 | 2.47 | Tibia 2 | 6.57 |
| Coxa 3 | 1.37 | Tarsus | .32 |
| Femur | 6.14 | Propodus | 1.53 |
| | | Claw | .73 |

*Distributions* Known only from its type-locality, Bering Island, Bering Sea.

*Depth range*: 132 m.

*Remarks*: Subsequent Russian records do not, to my knowledge, list this species or one like it as having been taken since the time of the Steamer Albatross. Hilton listed the type-locality as the California coast and the type as a female measuring 1.9 mm long. His description is relatively accurate, but his locality and measurement beg the question of just what specimen he was looking at when he listed these data.

This species bears a close resemblance to *P. femoratum,* and several others to a greater or lesser extent; *P. capense* Flynn, *P. quadradentatum* Hilton, *P. tubulariae* Lebour, and *P. ungellatum* Hedgpeth. *Phoxichilidium micropalpidum* differs from *P. femoratum* in the following respects: a longer and less curved propodus with three instead of five (sometimes four) heel spines and more sole spines; a much more setose propodus; and auxiliary claws fully half the main claw length, whereas with *P. femoratum*, they are usually ¼ or ⅕ the main claw length. Claw length varies, and Lebour (1945: 148, fig. 2a) figures auxiliary claws of ⅓ the main claw length on her British specimens. Most of these comparisons only touch lightly on diagnostic characters and would possibly fall within the normal variability of *P. femoratum*, if it were completely known. Hilton's type is much more pilose over all than are specimens of *P. femoratum* examined for comparison, and its size is larger. The movable finger of *P. femoratum* is consistently more swollen than the fingers of Hilton's type, and the palp tubercles are smaller and of a different shape. The conical capped ocular tubercle is taller on *P. micropalpidum*, and the lateral processes are without tubercles. Several specimens examined of *P. femoratum* have small distal lateral process

tubercles whereas others have none. This illustrates the disadvantage of having only one type-specimen rather than a type-series for comparison.

The remaining characters of the two species are similar and it may be that when more of Hilton's species are taken from the type-locality, it can be shown that the above variation will fall within that of *P. femoratum*.

### *Phoxichilidium parvum* Hilton
Figure 6a

*Phoxichilidium parvum* Hilton, 1939a: 28.—Hedgpeth, 1941: 257 [key]. —Hilton, 1942f: 71–72.
*Phoxichilidium hokkaidoense* Utinomi, 1954: 4–7, figs. 2–3, Pl. I, fig. 1.

*Material examined*: Male, holotype, USNM 81521, 18 male, female, and juvenile paratypes, USNM 124023: Three miles N of Santa Cruz, Santa Cruz County, California, coll. M. W. Williams, December, 1938.

*Remarks*: Utinomi has adequately figured this species as *P. hokkaidoense*, except for possibly the dorsal aspect. A figure of this is included here. Utinomi found as much variation in his specimens as is shown in the above type-lot. The holotype propodus more closely resembles his figure 3B (p. 6), while the oviger lacks the small terminal segment and is the same as figure 2H (p. 5). The leg has three dorsal femoral cement glands as in Utinomi's figure 2F, and the leg is only slightly smaller than his measurements (p. 7). The second tibia of the type is subequal to tibia 1 instead of being 0.9 times its length. The type-lot males have either five or six oviger segments, a factor that may be related to age.

Hilton erroneously published the type-locality as Vera Cruz, California. Williams (in USNM correspondence) corrected this to Santa Cruz, California. The type is partly squashed.

### *Phoxichilidium quadradentatum* Hilton

*Phoxichilidium quadradentatum* Hilton, 1942f: 71.—Hedgpeth, 1963: 1336–1337, fig. 9.
*Phoxichilidium quadridentatum*.—Hedgpeth, 1954: 204–205, fig. 93c. —MacGinitie, 1955: 171.

*Material examined*: Female, holotype: Stewart Island, Alaska, 50°23.5'N., coll. W. Williams, 4 August 1937, Lewis Expedition. USNM 81520.

*Remarks*: Latitude 50° N is not in Alaska, but corresponds with the latitude of Stuart Island, Strait of Georgia, British Columbia, Canada. There is also a Stuart Island, Bering Sea, Alaska, but Stewart Island eludes my geographical searches. Either location falls well within the species known distribution from San Francisco, California, to Point Barrow, Alaska.

This species has been figured by Hedgpeth (1954, 1963, 1964),

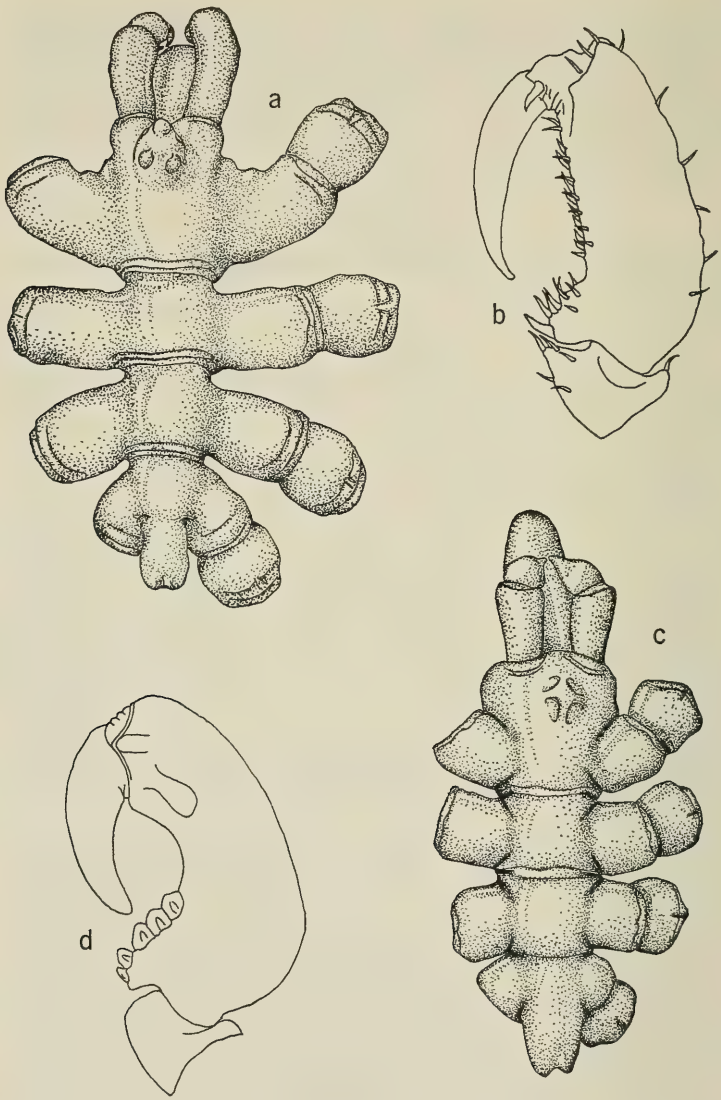



FIG. 6. a, *Phoxichilidium parvum*, holotype: Dorsal view of trunk; b, *Phoxichilidium* sp.: terminal segments of 3rd leg; c, d, *Pycnosoma strongylocentroti*: c, Dorsal view of trunk; D, terminal segments of 3rd leg.

but his propodus figure does not show the field of many median and lateral sole spines. The spines are mostly short and thick and extend proximally to the tarsus. Other specimens identified by Hilton and Hedgpeth were examined for comparison. The four heel spines appear to be constant, but the auxiliary claws vary from minute to just less than ¼ the main claw length. The femur has from 17 to 18 tiny dorsal cement glands in a single row.

*Phoxichilidium* sp.
Figure 6b

*Anoplodactylus unospinus* Hilton, 1942f: 73.—Stock, 1955: 243 [text].

*Material examined*: Juvenile male, holotype: Laguna Beach, southern California, coll. W. A. Hilton, low tide, August, 1917. USNM 81530. Includes another juvenile, paratype.

*Remarks*: It is possible this is a new species. The holotype is probably one moult away from an adult, and has most of the characters of the genus *Phoxichilidium*. The ovigers are about ⅔ formed. The specimen could be a juvenile *P. quadradentatum*, except for the single heel spine. The propodus should be fully formed by this late juvenile stage. There is no propodal lamina.

Hilton lists this species as if he described it in 1939, but no literature has been found from that year in which *A. unospinus* is listed. This may be a *lapsus* due to haste in publishing new species.

*Pycnosoma strongylocentroti* Losina-Losinsky
Figure 6c, d

*Pycnosoma strongylocentroti* Losina-Losinsky, 1933: 43–47, fig. 1.—Hedgpeth, 1947: 7 [footnote 2].—Hedgpeth, 1949: 239 [text].—Losina-Losinsky, 1961: 86.
*Pigrogromitus robustus* Hilton, 1942c: 40.

*Material examined*: Female, holotype: Captains Harbor, Unalaska Island, Aleutian Islands, Alaska, 16 m, coll. William H. Dall, 1874, no. 850(1189). USNM 13358.

*Remarks*: Losina-Losinsky has adequately illustrated (p. 45, Fig. 1) this species, but her figures do not show trunk segmentation nor do they emphasize the peculiar propodal heel spines. I have included figures of the trunk dorsally, and propodus for this reason, and because her paper is not always available to western specialists. Hilton's specimen is very robust, as his proposed name suggests, and is entirely glabrous except for the heel spines. The species superficially resembles *Pigrogromitus* in some particulars. Both genera lack palps, are robust with closely spaced lateral processes, have short and thick leg segments, and lack auxiliary claws. Hilton's specimen, as Hedgpeth (1947) pointed out, is not in the same genus because it has ovigers of six segments rather than 10, it has a one-segmented scape instead of two-

segmented, and a curved propodus with a very broad heel bearing six extremely broad blunt spines shaped like shovels. This last character alone is sufficient to distinguish *P. strongylocentroti* (and Losina-Losinsky's other species, *P. tuberculata*) from any other pycnogonid known to me.

Losina-Losinsky's types from Tatary Strait, Russian Siberia, and Hilton's specimen from Unalaska, appear to be the only records of *P. strongylocentroti*. The two recorded depths are 16 and 75 m.

## Literature Cited


Calman, W. T. 1927. Zoological Results of the Cambridge Expedition to the Suez Canal, 1924. XXVIII. Report on the Pycnogonida. Trans. Zool. Soc. London 22(3):403–410, figs. 102–104.

Hedgpeth, J. W. 1941. A key to the Pycnogonida of the Pacific Coast of North America. Trans. San Diego Soc. Nat. Hist. 9(26):253–264, pls. 9–11.

———. 1947. On the evolutionary significance of the Pycnogonida Smithson. Misc. Coll. (no. 3866) 106(18):1–53, 16 figs., 1 pl.

———. 1949. Report on the Pycnogonida collected by the Albatross in Japanese waters in 1900 and 1906. Proc. U.S. Nat. Mus. 98:243–321, figs. 18–51.

———. 1952. Class (or Subphylum) Pycnogonida, sea spiders. *In*: Ricketts and Calvin, Between Pacific Tides, 3rd ed., 430 pp.

———. 1954. Class Pycnogonida. *In*: S. F. Light's Manual of intertidal invertebrates of the Central California coast, R. I. Smith, ed. Univ. Calif. Press: i–xiv, 1–466, 138 figs. Second ed.

———. 1963. Pycnogonida of the North American Arctic. Jour. Fish. Res. Bd. Canada 20(5):1315–1348, figs. 1–12.

Hilton, W. A. 1914. The central nervous system of the Pycnogonid *Lecythorhynchus*. Pomona Jour. Ent. Zool. 6(3):134–136, 1 fig.

———. 1915a. Pycnogonids collected during the summer of 1914, at Laguna Beach. Ibid 7(1):67–70. March.

———. 1915b. Pycnogonids collected during the summer of 1915, at Laguna Beach. Ibid 7(3):201–206. September.

———. 1916a. A remarkable pycnogonid. Ibid 8(1):19–24, figs. 1–6. March.

———. 1916b. The life history of *Anoplodactylus Erectus* Cole. Ibid 8(1): 25–34, figs. 1–6. March.

———. 1916c. The nervous system of pycnogonids. Jour. Compar. Neurol. 26(5):463–473, figs. 1–21. October.

———. 1920. Notes on Pacific Coast Pycnogonids. Pomona Jour. Ent. and Zool. 12(4):93.

———. 1934. Notes on parasitic pycnognids [sic]. Ibid, 26(4):57.

———. 1939a. A preliminary list of pycnognids [sic] from the shores of California. Ibid 31(2):27–35. June.

———. 1939b. A collection of pycnognids [sic] from Santa Cruz Island. Ibid 31(4):72–74, 2 pl. December.

———. 1942a. Pantopoda chiefly from the Pacific. 1—Nymphonidae. Ibid 34(1):3–7. March.

———. 1942b. Pycnogonids from Allan Hancock Expeditions. Allan Hancock Pacific Expeds. 5(9):277–339, 14 pl. March.

———. 1942c. Pantopoda (Continued). II—Family Callipallenidae. Pomona Jour. Ent. and Zool. 34(2):38–41. June.

———. 1942d. Pycnogonids from Hawaii. Occ. Pap. Bernice P. Bishop Mus. 17(3):43–55, figs. 1–10. July.

———. 1942e. Pycnogonids from the Pacific. Family Tanystylidae. Pomona Jour. Ent. and Zool. 34(3):69–70. September.

———. 1942f. Pycnogonids from the Pacific. Family Phoxichilididae [sic] Sars 1891. Ibid 34(3):71–74. September.

———. 1942g. Pycnogonids from the Pacific. Family Ammotheidae. Ibid 34(4):93–99. December.

———. 1943a. Pycnogonids from the Pacific. Family Colossendeidae. Ibid 35(1):2–4. March.

———. 1943b. Pycnogonids of the Pacific. Family Pycnogonidae. Family Endeidae. Ibid 35(2):19. June.

Lebour, M. V. 1945. Notes on the Pycnogonida of Plymouth. Jour. Mar. Biol. Assoc. U.K. 26:139–165, 7 figs.

Losina-Losinsky, L. K. 1933. Pantopoda vostochnykh morei SSSR. [Die Pantopoden der östlichen Meere der USSR.] Issledovanie Morei SSSR 17:43–80. [With German summary: 74–79].

———. 1961. Mnogokolenchatye (Pantopoda) dalnevostochnykh morei SSSR. [Pantopoda of the far eastern seas of USSR.] Issledovanie Dalnevostochnykh Morei SSSR 7:47–117.

MacGinitie, G. E. 1955. Distribution and ecology of the marine invertebrates of Point Barrow, Alaska. Smithson. Misc. Coll. (no. 4221) 128(9):1–201.

Marcus, E. 1940. Os Pantopodia brasileiros e os demais sulamericanos. Bol. Fac. Fil., Ciênc. Letr. Univ. São Paulo (19) (Zool. 4):3–179, pls. 1–17.

Marcus, E. du Bois-Reymond. 1952. A hermaphrodite pantopod. Anais Acad. Bras. Ciênc. 24(1):23–30, figs. 1–9.

Stock, J. H. 1955. Pycnogonida from the West Indies, Central America, and the Pacific Coast of North America. Vidensk. Medd. Dansk Naturh. Foren. 117:209–266, figs. 1–26.

———. 1968. Pycnogonida collected by the Galathea and Anton Bruun in the Indian and Pacific Oceans. Ibid 131:7–65, 22 figs.

———. (In press). Pycnogonida. *In*: Shore and reef fauna of Hawaii, 2nd ed.

Utinomi, H. 1954. The fauna of Akkeshi Bay. XIX. Littoral Pycnogonida. Publ. Akkeshi Mar. Biol. Sta. 3:1–28, 11 figs., 1 pl.

73

QH
1
B4X
NH

No. 20, pp. 211–216 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SMITHSONIAN
AUG 27 1975
LIBRARIES

# A NEW GENUS AND SPECIES OF EURYURID MILLIPEDS FROM CHIAPAS (POLYDESMIDA: PLATYRHACIDAE)

By Richard L. Hoffman
*Radford College, Radford, Virginia 24142*

In recently working through the euryurid material in my collection during revisionary studies, I came across two specimens which had been sorted out and tentatively identified as referable to the genus *Polylepiscus* (on the basis of external appearance) nearly ten years ago. When the male was unrolled and the genitalia examined it was immediately obvious that a new generic type was represented, a conclusion reinforced by the remarkable modifications of the anterior sterna. Since this species is excluded from the genera *Amplinus* and *Pycnotropis*, both currently being monographed, it is here described separately.

As I have indicated elsewhere (in press), the euryurid millipeds might best be considered a subfamily of the Platyrhacidae instead of a separate family. The known genera of this subfamily fall into three relatively discrete groups which were treated as subfamilies in my 1954 synopsis. Of these taxa, now regarded as tribes, one (Aphelidesmini) is monobasic, one (Euryurini) contains two genera, while the third is much larger and comprehends no fewer than eight genera in the Neotropical Region. It is this third tribe, Amplinini, that the new genus finds its place, in the general vicinity of *Polylepiscus* and *Pycnotropis*.

The specimens described here are part of a large and extremely important collection of Mexican diplopods assembled in 1965 and 1966 by Drs. George E. Ball and Donald R. Whitehead during their own studies on Mexican carabids. I am very

much indebted to these assiduous collectors for their generosity in placing this valuable material at my disposal.

### Genus **Exallostethus,** new genus

*Type species*: *E. thrinax*, sp. nov., from Mexico (Chiapas).

*Diagnosis*: Distinguished from the superficially similar genera *Amplinus*, *Polylepiscus*, and *Pycnotropis* (and all other known euryurid genera) by the singular form of the gonopods and by the presence of enormous median processes on the sterna of segments 4 and 5 in males, and 4 in females. Collum without anterior marginal rim, likewise a unique character in this group. Stigmata dissimilar in size, posterior stigmata smaller and set obliquely between dorsal coxal condyles.

Gonopods without sclerotized median sternal remnant, but with a prominent thickened mass of membrane between the coxae; prefemur relatively short, its median face with greatly thickened setae, almost spurs, in addition to the usual slender hairs; acropodite elements elongated, much longer than prefemur, solenomerite very long, slender, and nearly straight, apically flattened and twisted; distal end of tibiotarsus enlarged and divided into two subsimilar apically acute lobes; postfemur with a long, slender, distally falcate process, another unique feature within the subfamily.

*Distribution*: Known so far only from the mountains of central Chiapas.

*Etymology*: The name is derived from the Greek *exallos*, utterly different + *stethos*, chest or sternum; bestowed in token of the remarkable modification of the anterior sterna in both sexes, not approximated in any other known euryurids. Gender masculine.

### **Exallostethus thrinax,** new species
Figures 1–4

*Diagnosis*: With the characters of the genus. Females similar to those of *Polylepiscus trimaculatus* (Hoffman, 1954) in general appearance but differ in that the posterior corners of the paranota of segments 3 and 4 are rounded instead of acute, the sides of the metaterga are coarsely granulate only along anterior and posterior margins, and in the presence of a prominent erect median process on the sternum of the 4th segment.

*Type-material*: Male holotype and female paratype from Highway 195, 11.6 miles north of Pueblo Nuevo, 5200 ft., Chiapas, Mexico; April 27, 1966; G. E. Ball and D. R. Whitehead, legg. (Hoffman Collection).

*Holotype*: Adult male, ca. 55 mm in length, 9.3 mm in maximum width, W/L ratio, 17.0%. Body increasing gradually in width from collum back to posterior ⅔ of body, thence narrowing abruptly over the last few segments as shown by the following dimensions:

| | |
|---|---|
| Segment 1–6.8 mm | Segment 10–9.2 mm |
| 2–7.6 | 12–9.3 |
| 4–8.3 | 14–9.3 |
| 6–9.1 | 16–8.8 |
| 8–9.1 | 18–7.1 |

Color of preserved specimen: dorsum of metaterga, most of head, and 6th antennomere rich maroon to chestnut brown; entire upper and lower surfaces of paranota and large median metatergal spot (median band on collum) nearly white; labrum and first four antennomeres yellowish; sterna light yellowish brown; legs uniformly brown; prozona and lower sides grayish.

Head moderately convex, smooth and polished, epicranial groove deep and prominent, bifurcate between antennae, its branches continuing ventrolaterad to ventral edge of antennal sockets. Latter set off below and laterally by a deep depression, subtended on each side by a large and prominent genal convexity, the median end of which is formed by a distinct vertical groove from lower edge of antennal socket. Lower half of genae planoconvex, without evident lateral margin, edge shallowly emarginate. Side of head behind antennae conspicuously ridged and grooved vertically. Frons elevated above level of genae and labroclypeus, in anterior aspect head appearing to be provided with two epicranial, a large triangular frontal, and two oval convex genal prominences. 0–0 epicranial setae; 1–1 interantennal; 1–1 widely spaced frontal; 4–4 clypeal, the outermost on each side remote from the median series of six; 10–10 labral; all setae multiple.

Antennae of moderate length (6.6 mm) and proportions, extending back to caudal edge of paranota of 3d segment. Articles 2–5 subclavate, enlarged apically, 6th cylindrical, 7th small, truncate-conic in shape. Length relationships: $3 > 4 = 5 = 6 > 2 > 1 > 7$.

Collum evenly arched, laterally depressed, entire surface smooth and polished except for very indistinct sublateral corrugation; lateral ends symmetrically rounded; anterior margin without trace of groove, surface continuous with edge. Collum appreciably narrower than width of second segment.

Body segments generally similar in structure; prozona and metazona separated by an evident 'waist' containing well-defined, faintly costulate stricture. Metazona dorsally slightly elevated above level of prozona. Surface of both subsegments smooth and polished middorsally, upper surface of paranota with several low and distinctly defined convex areas. Scapulorae marginal, those of segments 8 to 18 with an indistinct single row of minute, widely-spaced spicules forming a primitive strigil; peritreme strongly thickened near midlength, ozopore opening laterally in a large concavity (seen in dorsal aspect peritreme appears notched). Posterior corner of paranota right or obtusely angled back to segment 5, thence becoming increasingly acute and prolonged into a spiniform

process which on segments 12–15 is incurved. Posterior edge of paranota concave, with a single row of widely-spaced spicules extending in some cases to apex of peritrematic process.

Epiproct spatulate in outline, sides very slightly arcuate but converging distally; caudal edge nearly transverse, with six small lobes, of which the median two carry two pairs of long setae, one pair placed apically and the other on the ventral side somewhat removed from the rear edge. Paraprocts of the usual form, distinctly convex, surface wrinkled-striate, with polished median discal knob. Hypoproct large, tumid, subhemispheric in outline; apically truncate; setiferous tubercules absent, paramedian setae originate from sockets on edge of sclerite.

Podosterna strongly elevated, anterior and posterior faces nearly vertical; each divided by a deep transverse groove into two halves each with a shallower, broader longitudinal median depression, the quadrants thus formed not notably produced as subcoxal lobes or projections; sternal surface smooth and glabrous. Stricture broad and poorly-defined down sides of segments, anterior edge fairly distinct across midventral region. Sides of metazona with an area of enlarged acute tubercules just behind stricture and another near caudal margin, beginning on underside of paranota and extending to supracoxal region where broadened and with tubercules larger and denser. Central area of metazonal sides with only a few small and scattered tubercules. Stigmata prominent, elongate and very slender, anterior stigmata placed entirely in stricture, in front of dorsal coxal condyle but well removed from it, rim only very slightly raised; posterior stigmata about half as long as anterior, placed between dorsal coxal condyles and slanted obliquely forward, edges slightly elevated with dorsal end somewhat expanded and subauriculate. Dorsal condyles relatively large and prominent, projecting laterally.

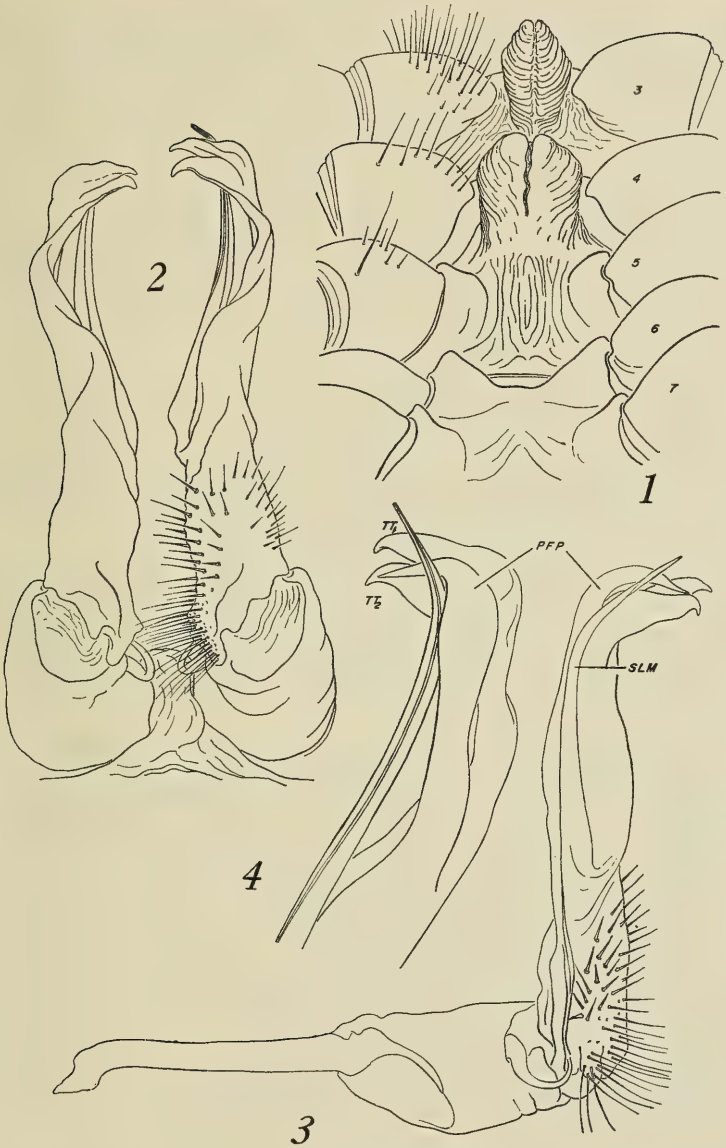
Legs relatively large and robust, but short, only the three distalmost podomeres extend beyond edges of paranota, length at midbody about 7.8 mm, tarsal claw large, curved, about 0.8 mm in length. Podomeres nearly glabrous except for sparsely scattered microsetae, and with macrosetae dispersed as follows: one on ventral side of coxa, prefemur, femur, and postfemur, ventral side of tibia with two, and of tarsus with three; tibia with one lateral macroseta on each side, and apical half of tarsus with about 10–12 dorsolaterally placed setae. Relative lengths of podomeres: $3 > 6 > 2 > 1 = 4 > 5$.

Anterior sterna as shown in Fig. 1: a large median process between

---

→

Figs. 1–4. *Exallostethus thrinax*, sp. n. 1, sternal region and bases of legs of segments 4, 5, and 6, showing sternal modifications and reduction of ventral coxal setae (small numbers at right refer to the leg pair). 2, gonopods, ventral (aboral) aspect, as would be seen *in situ*. 3, left gonopod, mesal aspect. 4, distal half of telopodite of right




gonopod, dorsal (oral) aspect, to show relationships of terminal branches, enlarged. Figures 1–3 drawn × 45, Figure 4, × 90. Abbreviations: PFP, postfemoral process; SLM, solenomerite, $TT_1$ and $TT_2$, apical lobes of the tibiotarsus.

legs of the 3rd pair, its surface closely and coarsely striate and with deep vertical groove on posterior side; segment 5 with massive median projection between 4th legpair and a low median ridge between 5th legs; sternum of segment 6 broad, medially planoconcave with prominently developed subcoxal lobes. Legs: 1st and 2nd pairs relatively setose, 3rd pair with only a field of ventral setae on coxae and several dispersed hairs elsewhere; coxal setae decrease as shown, to only one large seta on 6th pair. Anterior legs unmodified.

Gonopod aperture small, oval, anterior edge reaching to stricture but slightly elevated above it; posterior edge somewhat elevated and thickened. Gonopod large, elongate, projecting forward to sternal process of segment 5. No sclerotized sternal remnant present, but coxae separated by a large median lobe of whitish heavy membrane; sternal apodemes slender, slightly longer than coxae.

Gonopods as shown in Figures 2–4; prefemoral region short and set medially with unusually stout setae, almost spurs, of a form not found elsewhere in the Euryurinae; acropodite much longer than prefemur, composed of a long, attenuated, distally ribbon-like solenomerite (SLM), a large, apically broadened and falcate postfemoral process (PFP) likewise unique in this group; and a medially curved tibiotarsus, apically divided into two similar uncate laminate terminal lobes.

*Paratype*: Adult female, length about 60 mm (specimen broken), body outline similar to that of male, i.e., very narrow anteriorly, becoming broader back to about 14th segment, thence tapering abruptly posteriad. Width of collum, 7.2 mm; segment 2, 8.0 mm; segment 4, 9.0 mm; segment 6, 10.0 mm; segment 10, 10.2 mm; segment 14, 10.5 mm. W/L ratio, 17.5%.

Color pattern similar to that of male, but median spots appreciably larger, occupying up to half of metatergal middorsal region. Structure generally as in male except: anterior edge of collum with marginal ridge indicated for a short distance just behind mandibular condyle; tergal sculpture more pronounced, upper side of paranota distinctly areate; costulation of stricture more distinct; posteriormost segments with low but evident transverse series of small tubercules; paranota appreciably smaller than in male but otherwise similar; legs more slender; sternum of 4th segment with an erect median process, somewhat smaller than that of male; sternum of 5th segment with two approximate paramedian knobs between 4th pair of legs, and two lower, more widely spaced knobs between 5th pair.

*Etymology*: The specific name is the Greek word for a three-parted implement, and relates to the three distal elements of the gonopod telopodite.

## Literature Cited

Hoffman, Richard L. 1954. Further studies on American millipeds of the family Euryuridae (Polydesmida). Jour. Washington Acad. Sci. 44:49–58, figs. 1–4.

73

QH
1
B4X
NH

o. 21, pp. 217–232 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# TAXONOMIC NOTES OF THE GENUS *ONCAEA* (COPEPODA: CYCLOPOIDA) FROM THE GULF OF MEXICO AND NORTHERN CARIBBEAN SEA

By Frank D. Ferrari
*Smithsonian Oceanographic Sorting Center*
*Washington, D.C. 20560*

SMITHSONIAN INSTITUTION
NOV 25 1975
LIBRARIES

Copepods of the genus *Oncaea* are small cyclopoids between 0.2 mm and 1.4 mm long. They are abundant in the epipelagic zone of the tropical oceans and although they are often regarded as free-swimming members of the zooplankton community, the minute structure of the mouthparts (Sars, 1918), the reports of food procurement for some members of the genus (Wickstead, 1962; Heinrich (= Geinrich), 1957; Alldredge, 1972), and for the ecologically related genus *Sapphirina* (Heron, 1973), indicate that they probably maintain semi-parasitic relationships with other members of the zooplankton community. Because of their small size, the absence of obvious morphological differences, and the intraspecific size variability, the species are difficult to identify. In this paper the common larger species of the Gulf of Mexico and Northern Caribbean Sea are described and some of the variability encountered in these species is discussed.

Forty-one zooplankton samples were collected in July, 1969, September, 1971, and May–June, 1972, from the upper 500 m in the area beyond the continental shelf in the Gulf of Mexico and Northern Caribbean Sea (hereafter the Gulf area). The mesh width of the finest nets used was 216 microns. Problems with retention limited the study to the larger members of the genus *Oncaea* but a single Bongo-net tow (mesh width 183 microns) taken in March, 1973, from the northeastern Gulf

of Mexico, provided females of three small species. Much of the information given here, including comprehensive station details, were initially reported in a Ph. D. dissertation (Ferrari, 1973).

Specimens were measured and dissected in latic acid and transferred to glycerol to be drawn with the aid of a camera lucida. Fixing with formaldehyde causes various degrees of flexation of the prosome and urosome and telescoping of the urosome segments in *Oncaea*. By positioning the animal for measurement, errors caused by flexation can be avoided. Adjustment for telescoping of segments is more tedious. The total length of a specimen was calculated simply as sum of the measurements of the prosome and urosome and was not adjusted for telescoping of segments. However measurements made for comparing the relative lengths of different abdominal segments were adjusted for the telescoping effect.

*Oncaea conifera* Giesbrecht 1891
Figures 1A–2G

Females of *Oncaea conifera* (length 1.01–1.26 mm) represent one of the four large species (total length greater than 0.70 mm) in the Gulf area. These females and those of *O. similis* can be distinguished from all other females by the distal conical projection of third segment of the endopod of the fourth swimming leg. Greater total length and, generally, some development of a dorsal projection on the second pedigerous segment separates *O. conifera* from *O. similis*. Males of *O. conifera* were the only males found in this study with a conical projection on the third segment of the endopod of the fourth swimming leg. Males of *O. similis* share this trait but were not collected. For purposes of identification, Olson (1949), who first described the males of *O. similis*, states that the terminal seta of the third endopodal segment of the second swimming leg is more prominent than the two external setae. In the males of *O. conifera* this terminal seta is less prominent.

*O. conifera* poses the most complex problem of variation of any species in the genus. Farran (1936) described size variation from the more limited area of the Great Barrier Reef. He divided 40 females into three groups one of which he called a variety. These three groups were often found in the same sample. Moulton (1973) described morphological variation of this species in the Indian Ocean. His study included a comprehensive numerical analysis of 23 females from two stations. From this analysis he recognized four groups, three of which were referable to those of Farran.

Specimens separated and counted from the Gulf area exhibited a wide

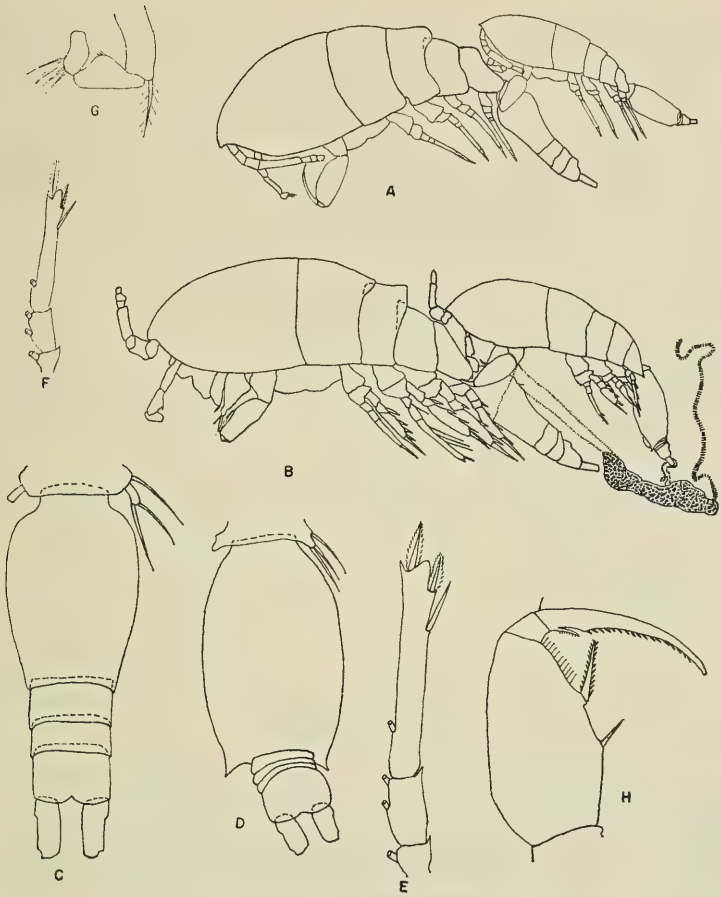



FIG. 1. *Oncaea conifera*: A, Small male-female pair, lateral; B, Large male-female pair, lateral; C, Female Ur, dorsal; D, Male Ur, dorsal; E, Female Enp3 P4; F, Male Enp3 P4; G, Male A2; H, Female, Mxpd.

degree of variation. Some individuals could be easily placed in either of Farran's groups, others could not; no systematic analysis by depth, water mass, or season was attempted. However, during the study, at seven different stations, seven male–female pairs of *O. conifera* were found in what is considered a mating posture (Fig. 1A, 1B). In these instances the male had grasped the female in the area of the articulation of the genital segment and the preceding urosomal segment. Grasping was done only with the large distal claws of the maxillipeds. In ad-

dition some accessory structures were found in one pair (Fig. 1B). The genital segment and the tip of the endopod of the fourth swimming leg of the female was encircled by a line composed of twisted strands. Both ends of this line passed outside and over the maxilliped of the the male and into the area of the mouthparts. From this area both lines passed tautly back to an irregular mass of tubules or cells ventral to the male urosome. One small line, originating from this mass, seemed to wrap loosely around the caudal ramus and caudal setae of the male and terminate in the mass. Another thicker line dangled from the mass. As these two animals were collected with a net, held in a catch bucket for a period of time until the tow was completed and then exposed to the shock of fixation with formaldehyde, it is difficult to assess the significance of the position of these structures. Since they have not been recorded previously they have been included here.

Below is a list of the lengths (in mm) of the seven male–female pairs of *O. conifera.*

| females | males |
|---|---|
| 1.06* | 0.60* |
| 1.09 | 0.63 |
| 1.09 | 0.65 |
| 1.11 | 0.60 |
| 1.11 | 0.82 |
| 1.12 | 0.64 |
| 1.25+ | 0.79+ |

*Fig. 1A; +Fig. 1B

Had these 14 individuals occurred separated in a sample they could easily have been grouped into two size classes for both sexes (females: 1.06–1.12 and 1.25 mm; males: 0.60–0.65 and 0.79–0.82 mm). In six of the seven cases the data indicate that the females and males paired according to these size classes; the fifth pair is the exception. Incompatability of size could be a premating isolation mechanism but caution should be exercised in extrapolating from this mating posture to actual reproduction.

The females of these pairs all have a well developed dorsal projection of the second pedigerous segment and the body is well sclerotized. The posterio-lateral extensions of the last prosomal segment are parallel. The anal segment is not quite as long as the preceding two abdominal segments together and the caudal rami are set wide apart. Morphologically these females seem to belong to the "a" group of Farran (1936) although their total lengths lie outside the range reported by him. They also fit the "stocky" group of Moulton (1973) which, Moulton notes, is very similar to the "a" group of Farran.

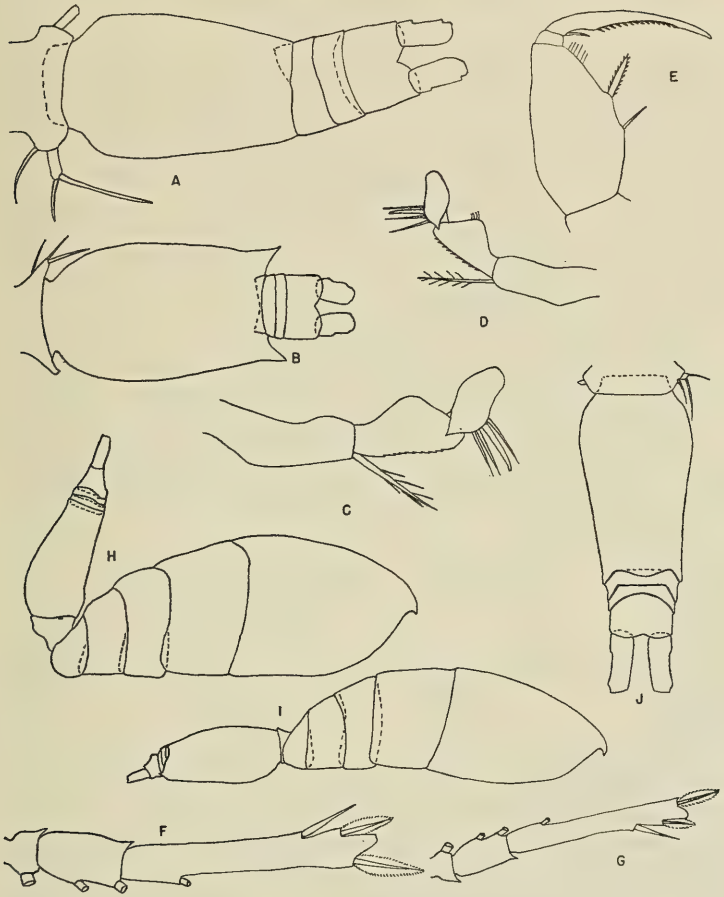



FIG. 2. *Oncaea conifera*: A, Female Ur, dorsal; B, Male Ur, dorsal; C, Female A2; D, Male A2; E, Female Mxpd; F, Female Enp P4; G, Male Enp P4; *Oncaea media*: H, Female, lateral; I, Male, lateral; J, Female Ur, dorsal, flexed dorsally.

Two male–female pairs were dissected and certain structures drawn. Fig. 1C–H is the small female–small male pair illustrated in Fig. 1A; Fig. 2A–G is the large male–large female of Fig. 1B. The only notable difference between these two pairs is the slight serration on the second segment of A2 in both male and female of the large female–large male pair.

*Oncaea media* Giesbrecht 1891
Figures 2H–3D

In the Gulf area the females of this species are easily separated from all others encountered by their deep blue coloration in reflected light. Farran (1929) remarks that females found around New Zealand were crimson while Sewell (1947) notes an orange-red color for some of his specimens from the northern Arabian Sea. The males are characterized, as are those of *O. venusta*, by the short curved spine in the proximal group of spines and setae of the third segment of second antenna (Fig. 3B). The males are separated from those of *O. venusta* by their smaller size and smaller length of the caudal ramus relative to the anal segment (compare Fig. 3A with Fig. 6B).

Females of *O. media* were collected extensively in the Gulf area in July, 1969. The individuals were referable to the major form of Sewell (1947) on the basis of length range, 0.72–0.81 mm. The species was not found in September, 1971, or May–June, 1972, but was found again in the single sample collected in March, 1973. The length range of these specimens, 0.73–0.93 mm, exceeded that of the specimens collected in July, 1969. Below is a list of lengths for a sample of 30 females from each year.

| Length (mm) | .72 | .73 | .74 | .75 | .76 | .77 | .78 | .79 | .80 | .81 | .82 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | 2 | 2 | 2 | – | 3 | 5 | 7 | 5 | 1 | 3 | – |
| 1973 | – | – | – | 1 | 2 | – | 1 | – | 1 | 2 | 3 |

| Length (mm) | .83 | .84 | .85 | .86 | .87 | .88 | .89 | .90 | .91 | .92 | .93 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | – | – | – | – | – | – | – | – | – | – | – |
| 1973 | 2 | – | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 2 |

Small individuals which could be ascribed to Sewell's minor form, length range 0.58–0.65 mm, were not collected from the Gulf area at any time. The nets of the 1969 survey, mesh width 333 microns, may not have retained specimens of this size but if present, they should have been found in the sample of 1973, mesh width 183 microns, because smaller specimens of the genus were collected. A single male 0.63 mm long was found in the 1969 samples; the length range of 10 males from the sample of 1973 was 0.56–0.62 mm.

*Oncaea mediterranea* Claus (1863)
Figures 3E–5D

Females of *Oncaea mediterranea* can be separated with *O. venusta* from other oncaeids by the length of the caudal ramus, more than 2.5 times longer than wide (Fig. 3G). Females can be separated from those of *O. venusta* by their longer fifth leg (Fig. 3G) which is reduced in *O. venusta* (Fig. 5J), and by the structure of the maxilliped, especially the distal spine on the second basipod segment, which is

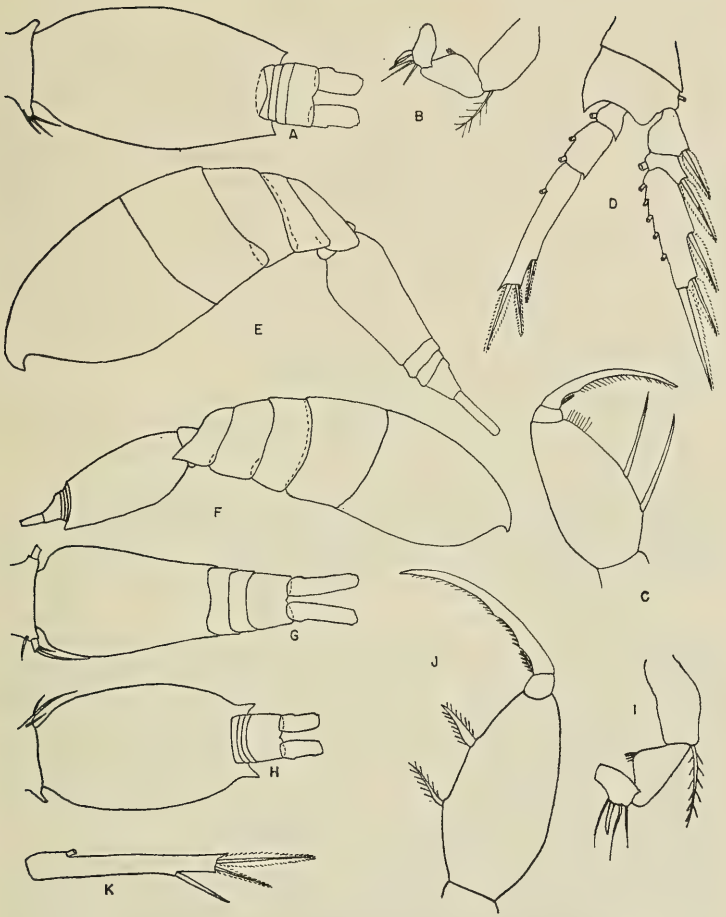



Fig. 3. *Oncaea media*: A, Male Ur, dorsal; B, Male A2; C, Female Mxpd; D, Female P4; *Oncaea mediterranea* typical group: E, Female, lateral; F, Male, lateral; G, Female Ur, dorsal; G, Male Ur, dorsal; I, Male A2; J, Female Mxpd; K, Female, Enp3 P4.

toothed on *O. mediterranea* (Fig. 3J) but setose on *O. venusta* (Fig. 6C). Males of *O. mediterranea* and *O. venusta* have distinctive caudal rami that are more than 3 times longer than wide and longer than the anal segment. The two species can be separated by the presence of a seta instead of a curved spine on the third segment of the second antenna in *O. mediterranea* (compare Fig. 3I with 6D).

There are three distinct size groups of both males and females of *O. mediterranea* from the Gulf area. The length range of the typical group, females 1.07–1.22 mm and males 0.76–0.89 mm, falls within the range for females reported by other authors (Giesbrecht, 1892; Rose, 1933; Farran, 1936). In samples from the Gulf area this group always makes up a relatively greater number of individuals than the large group. The length range of the larger group, females 1.29–1.37 mm and males 1.06–1.12 mm, exceeds the upper limit usually reported for the females, although Olson (1949) reported the length of *O. mediterranea* from the east coast of the Pacific Ocean as 1.38 mm. There are no morphological differences in the appendages of these two groups but the larger group is easily distinguished by its greater total length, more heavily sclerotized exoskeleton, and greater amount of orange pigment on the extremities of the body and appendages.

Farran (1929) reported "a small colorless form" of *O. mediterranea* in a sample taken south of New Zealand but gave no further description of the specimen. A similar group of *O. mediterranea* was collected abundantly throughout the Gulf area during the four years studied. Individuals of this third group are smaller, females 0.85–0.91 mm and males 0.69–0.75 mm, than previously reported for *O. mediterranea*. This small group differs from the preceding two in its lack of pigment and its more weakly sclerotized exoskeleton. Its caudal rami are parallel to one another, not divergent as in the other two groups (compare Fig. 3G with Fig. 5C). The caudal ramus length to width ratio is 3.0 to 3.5 while for the other two groups it is greater than 4.0; the ratio of caudal ramus length to anal length is 1.0 in the small group and 1.6 in the other two groups. In Fig. 4 measurements of 30 females, randomly selected from a general collection of *O. mediterranea*, are used to indicate these three separate groups. Males of the small group can be distinguished most easily by the shorter total length, lack of pigment and minimal sclerotization of the exoskeleton.

The small group was tentatively treated as a new species by Ferrari (1973) because it differed in relative lengths of the body segments as well as in total body length, whereas the large and typical groups differed only in total body length. However, other species of *Oncaea*, specifically *O. conifera*, also exhibit a great degree of relative size variation. Since this variation in *O. mediterranea* is not accompanied by structural differences in the appendages, it is not considered great enough to warrant recognition as a species.

### *Oncaea similis* Sars 1918
Figures 5E–H

Due to its very small size *Oncaea similis* was collected only in the March, 1973, sample (mesh width 183 microns) and only females of this species were found. Separation of these females has been discussed under *O. conifera*.

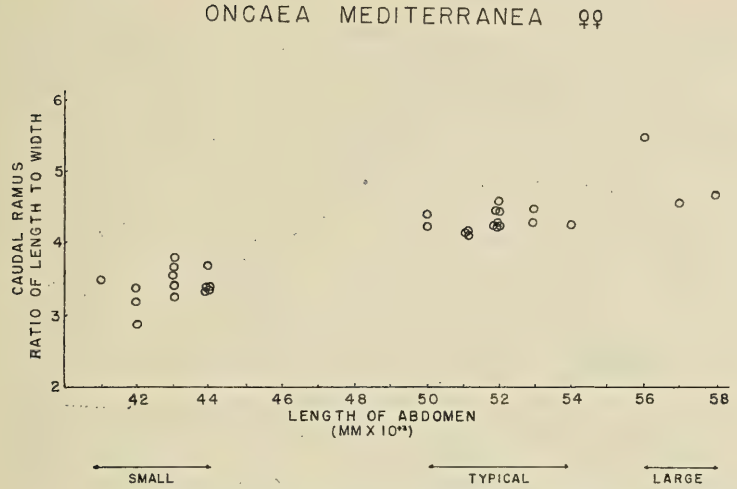



Fig. 4. Length of the abdomen plotted against length-width ratio from 30 females randomly selected from a general collection of *Oncaea mediterranea* from the Gulf area.

Specimens from the Gulf area differ slightly from those described by Sars (1918) but agree well with the description of Olson (1949) for *O. similis* from the coastal waters of the eastern Pacific Ocean. Sars lists the total length of the adult females as 0.78 mm while those from the Gulf area are 0.62–0.65 mm. The genital segment does not gradually taper posteriorly from its widest to narrowest width; rather the anterior area is more rounded and the posterior portion distinctly cylindrical (Fig. 5F) as in Olson (1949). The second abdominal segment is longer than the third; the medial spine of P5 is much thicker than the lateral. The spines on the second basipodal segment of the maxilliped are dissimilar, the distal one being longer, stouter, and toothed.

*Oncaea venusta* Philippi 1843
Figures 5I–6D

The separation of *Oncaea venusta* has been discussed with *O. media* and *O. mediterranea.* Males of the former species and females of the latter are the only ones which might cause confusion. Two size groups were found in the Gulf area, females 0.92–0.99 mm, males 0.57–0.63 mm and females 1.10–1.20 mm, males 0.76–0.86 mm, throughout the period sampled. These correspond respectively to forma *venella* and forma *typica* described by Farran (1929) and noted by Sewell (1947). Although there are slight differences in the length ranges reported in all three cases, the presence of distinct size groups is consistant. On page

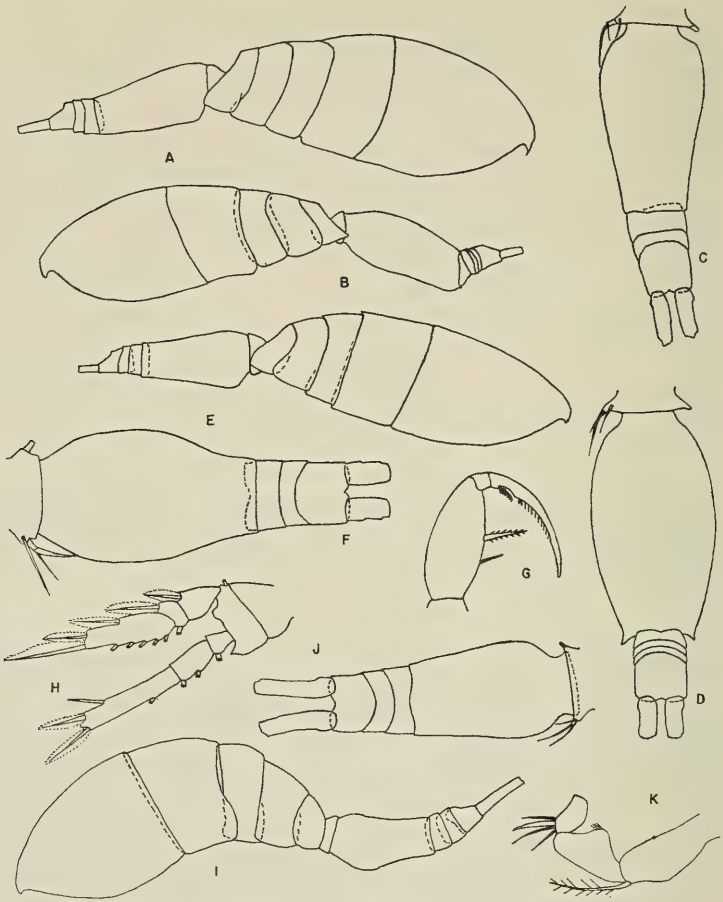



FIG. 5. *Oncaea mediterranea* new group: A, Female, lateral; B, Male, lateral;! C, female Ur, dorsal; D, Male Ur, dorsal; *Oncaea similis*: E, female, lateral; F, Female Ur, dorsal; F, Female Mxpd; H. Female, P4; *Oncaea venusta* typical group: I, Female, lateral; J, Female Ur, dorsal; K, Female A2.

228 is a list of the lengths of 30 females and 30 males randomly selected from a general collection of the species.

Both groups were present in the Gulf area during all four years studied. In all stations the smaller group was by far the more abundant, which contradicts the findings of Farran (1929) from New Zealand and Sewell (1943) from the Arabian Sea. Both groups from the Gulf area,

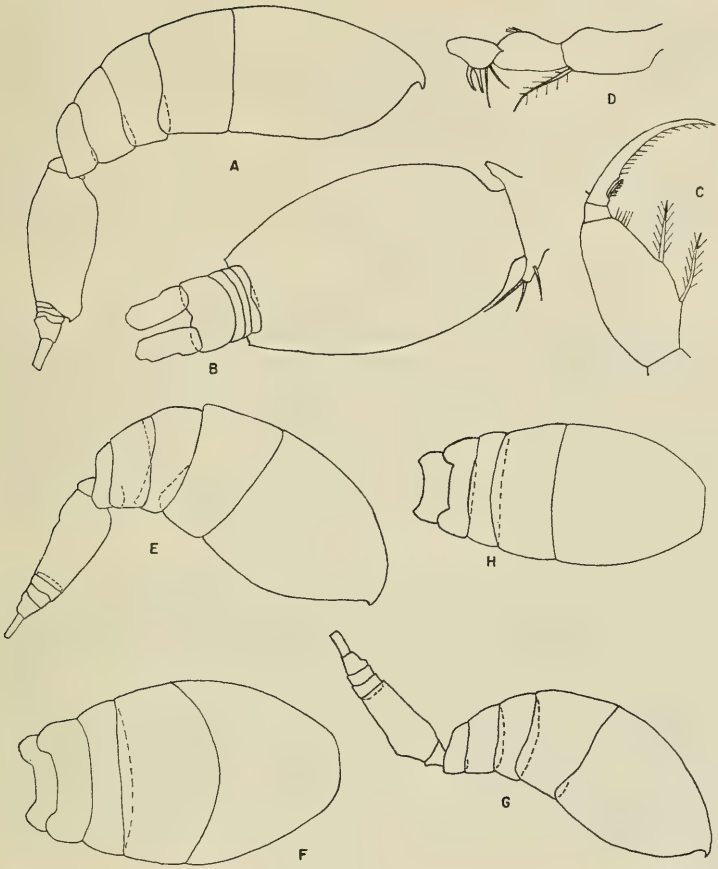



FIG. 6. *Oncaea venusta* typical group: A, Male, lateral; B, Male Ur, dorsal; C, Female Mxpd; D, Male, A2; *Oncaea* sp. 1: E, Female, lateral; F, Female Pr, dorsal; *Oncaea* sp. 2: G, Female, lateral; H, Female Pr, dorsal.

when viewed under reflected light, are tinged with red on the extremities of the body and appendages. This coloration agrees with specimens described by Farran (1929) from the Great Barrier Reef but Giesbrecht (1891), Rose (1933), and Owre and Foyo (1967) describe this species as purple.

The following two females were recovered from the sample collected in the net with mesh width of 183 microns. In the keys of Rose (1933) and Shmeleva (1969), *Oncaea* sp. 1 and *Onceae* sp. 2 fall between *O. media* and *O. curta*.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Length (mm) | .93 | .94 | .95 | .96 | .97 | .98 | .99 | — | 1.10 | 1.11 |
| females | 3 | 3 | 5 | 6 | 3 | 2 | 1 | | – | 2 |
| Length (mm) | | 1.12 | 1.13 | 1.14 | 1.15 | 1.16 | 1.17 | 1.18 | 1.19 | 1.20 |
| females | | 1 | – | 1 | 1 | 1 | – | 1 | – | – |
| Length (mm) | .57 | .58 | .59 | .60 | .61 | .62 | .63 | — | .76 | .77 |
| males | – | – | 1 | 5 | 12 | 8 | – | | – | – |
| Length (mm) | | .78 | .79 | .80 | .81 | .82 | .83 | .84 | .85 | .86 |
| males | | 1 | – | 2 | – | – | 1 | – | 1 | – |

*Oncaea* sp. 1
Figures 6E, F and 7A–D

Length 0.68 to 0.71 mm. Prosome 68% of total length. Third segment of second antenna shorter than second. Spines of second basipodal segment equal; both spines with a row of short, fine hairs. Fine hairs on medial margin of terminal hook of maxilliped. First three swimming legs as figured for *O. curta* in Sars (1916); fourth without terminal cone on endopod; third segment of its endopod with two lanceolate setae; the proximal external seta naked. Genital segment longer than rest of urosome; caudal ramus longer than anal segment. Urosome formula 8,53,8,6,8,17 = 100.

This female resembles *O. curta* Sars (1916). Third segment of second antenna is proportionally shorter than second, as compared to Sars' drawing. Other differences: the setae on second basipod of maxilliped are unequal, genital segment proportionally wider, genital segment longer than rest of urosome. In the description of *O. curta* Sars states ". . . tail does not exceed half the length of the anterior division and having a shorter genital segment than *O. media* being in length equal to the rest of the tail." However, Olson (1949) figures *O. curta* with the genital segment longer than the rest of the urosome. Until the males can be found and described no decision can be made as to whether this is a new species or another size group of *O. curta*.

*Oncaea* sp. 2
Figures 6G, H and 7E–H

Total length range of these females, 0.54–0.58 mm. Prosome twice urosome. Caudal ramus slightly longer than anal segment which is longer than third abdominal segment. Genital segment longer than rest of urosome. Urosome formula 6,53,10,7,10,14 = 100. Appendages similar to those of *Oncaea* sp. 1 but smaller and narrower. These females are easily separated from those of *Oncaea* sp. 1 by the shorter total length, narrower prosome and urosome, and the less arched aspect of the prosome.

## Discussion

Due to their small size, variation in the species of the genus *Oncaea* is often overlooked. Several types of variation have been observed or

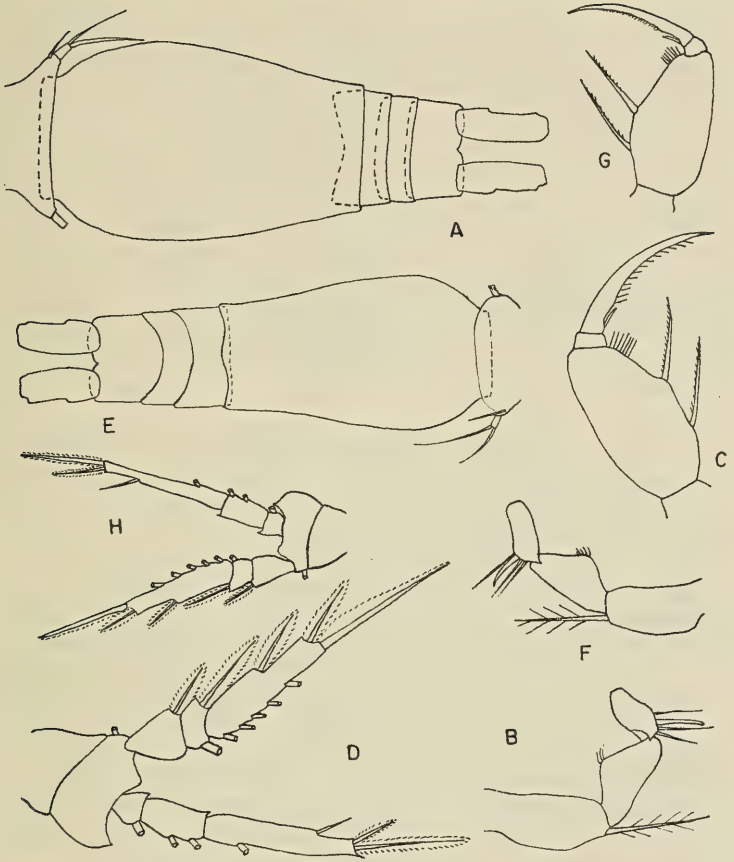



FIG. 7. *Oncaea* sp. 1: A, Female Ur, dorsal; B, Female, A2; C, Female Mxpd; D, Female P4; *Oncaea* sp. 2: E, Female Ur, dorsal; F, Female A2; G, Female Mxpd; H, Female P4.

cited here. Color variation within the same species from different geographic regions is noted in *O. media* and *O. venusta.* Simple size variation, in which only the total length of the specimens varies, is found in *O. media, O. mediterranea,* and *O. venusta* from the Gulf area and reported for *O. venusta* by Farran (1929) and Sewell (1947) and for *O. media* by Sewell (1947). Relative size variation, in which the size of certain body segments varies in relation to one another, is demonstrated for *O. mediterranea* from the Gulf area and reported for *O. conifera* by Farran (1936) and Moulton (1973). Both kinds of size variation can produce definite size groups of specimens; these size

groups can be consistant over space and time, e.g., *O. mediterranea* and *O. venusta*, or change temporally, e.g. *O. media*. If these groups are different species, distinctions in appendage morphology should be noticable, especially in those appendages of the male involved in reproductive behavior. However, distinctions in the male maxillipeds have not been noted so far. It is possible that the behavior of the male in securing the female with accessory reproductive structures (noted in *O. conifera*) may act as a premating isolation mechanism. Finally it should be noted that variation in seven male–female pairs of *O. conifera*, captured in what is believed to be a mating posture, is not broad as the variation in the rest of the population in the Gulf area. These seven females fit into only one of the several previously described groups of *O. conifera*. It is possible in this species that only certain females are actually capable of attracting males for the purpose of reproduction.

### Key to the Species of *Oncaea*

Ur 5 segmented ..... females
Ur 6 segmented ..... males

#### Females

1. Enp3 of P4 with a distal conical projection ..... 2
   Enp3 of P4 without projection ..... 3
2. Th2 usually with pronounced hump at the dorsal midline; total length greater than 0.90 mm ..... *O. conifera*
   Th2 without this hump; total length less than 0.80 mm ..... *O. similis*
3. Caudal ramus less than 3 times as long as wide ..... *O. media*
   Caudal ramus 3–5 times as long as wide ..... 4
4. Body heavily sclerotized; Pr strongly arched; P5 short ..... *O. venusta*
   Body not as sclerotized; Pr not arched; P5 elongated ..... *O. mediterranea*

#### Males

1. Enp3 of P4 with a terminal rounded projection ..... *O. conifera*
   Enp3 of P4 without this projection ..... 2
2. Seg3 of A2, proximal set of spines and setae with 2 thick spines and 2 thin setae ..... 3
   Seg3 of A2, proximal set of spines and setae with 1 thin seta, 1 thick spine, and 2 thin setae ..... *O. mediterranea*
3. Ratio, caudal ramus length to Ansg length, less than 2 ..... *O. media*
   This ratio greater than 2 ..... *O. venusta*

### Acknowledgments

I would like to thank Drs. John Wormuth and Leo Berner of Texas A&M University and Dr. Thomas Bowman of the National Museum of Natural History.

Literature Cited

Alldredge, A. 1972. Abandoned larvacean houses: a unique food source in the pelagic environment. Science 177:885–887.

Farran, G. 1929. British Antarctic ("TERRA NOVA") Expedition, 1910. Natural History Report. Zoology VIII (3):203–306.

———. 1936. Great Barrier Reef Expedition, 1928–1929. Scientific Reports V(3):126–128.

Ferrari, F. 1973. Some Corycaeidae and Oncaeidae (Copepoda: Cyclopoida) from the epipelagic waters of the Gulf of Mexico. Ph. D. Dissertation. Texas A&M University. 214 pp.

Giesbrecht, W. 1892. Systematic und Faunistic der pelagischen Copepoden des Golfes von Neapel. Fauna u Flora des Golfes von Neapel. XIX:590–604.

Heinrich, A. 1957. On the nutrition of marine copepods in the tropical region. Dokl. Akad. Nauk. S.S.S.R. 119:1029 (in Russian).

Heron, A. 1973. A specialized predator-prey relationship between the copepod *Sapphirina angusta* and the pelagic tunicate *Thalia democratica*. Jour. Mar. Biol. Ass. U.K. 53:429–435.

Moulton, T. 1973. Principle component analysis of variation in form within *Oncaea conifera* Giesbrecht, 1891, a species of copepod (Crustacea). Syst. Zool. 22(2):141–156.

Olson, F. 1949. The pelagic cyclopoid copepods of the coastal waters of Oregon, California and lower California. Ph. D. Thesis, University of California, Los Angeles. 208 pp.

Owre, H. and M. Foyo. 1967. Copepods of the Florida Current. Fauna Caribbaea, No. 1, Crustacea, Part 1: Copepoda p. 110–112.

Rose, M. 1933. Copepodes pelagiques. Faune de France 26:295–303.

Sars, G. 1916. Liste systematique des Cyclopoides, Harpacticoides et Monstrilloides recueillis pendant les campagnes de S.A.S. le Prince Albert de Monaco, avec descriptions et figures des especes nouvelles. Bull. Inst. Oceanogr. Monaco 323:1–15.

———. 1918. An Account of the Crustacea of Norway. VI Copepoda, Cyclopoida 193 pp.

Sewell, R. 1947. The John Murray Expedition 1933–34. The Free-Swimming Planktonic Copepoda. Systematic Account VIII(1): 258–264.

Shmeleva, A. 1969. Espèces nouvelles du genre *Oncaea* (Copepoda, Cyclopoida) de la mer Adriatique. Bull. Inst. Oceanogr. Monaco 68(1393):1–28.

Wickstead, J. 1962. Food and feeding in pelagic copepods. Proc. Zool. Soc. London 139:545–555.

73

QH
1
B4X
NH

No. 22, pp. 233–248 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SMITHSONIAN
AUG 29 1975
LIBRARIES

# REVIEW OF THE GENUS *HERMENIA*, WITH A DESCRIPTION OF A NEW SPECIES (POLYCHAETA: POLYNOIDAE: LEPIDONOTINAE)

By Marian H. Pettibone
*Smithsonian Institution, Washington, D.C. 20560*

As a part of my revisionary work on the aphroditoid polychaetes, a study was made of the members of the genus *Hermenia* Grube (Polynoidae: Lepidonotinae). Three species have been described previously, one of them both a homonym and a synonym. A new species is added herein, based on material previously confused with one of the currently recognized species. The species, treated in this report are:

*H. verruculosa* Grube, 1856. Virgin Islands
[Includes *Polynoe nodosa* Treadwell, 1901 (= homonym). Puerto Rico]

*H. acantholepis* (Grube, 1876), as *Polynoe*. Philippine Islands

*H. neoverruculosa* new species, as *H. verruculosa* by Monro, 1939. Seychelles

In addition to the specimens in the Smithsonian Institution, Washington (USNM), types and additional material were borrowed from the following Museums: Bernice P. Bishop Museum, Honolulu (BPBM), through D. M. Devaney; British Museum (Natural History), London (BMNH), through J. D. George; Museum National d'Histoire Naturelle, Paris (MNHNP), through J. Renaud-Mornant; Rijksmuseum van Natuurlijke Historie, Leiden (RMNHL), through J. van der Land; University Zoological Museum, Copenhagen (UZMC), through J. B. Kirkegaard; Zoölogisch Museum, Amsterdam (ZMA), through S. van der Spoel, and Zoologisches Institut

and Museum, Hamburg (ZMH), through G. Hartmann-Schröder. The manuscript benefited from the suggestions of H. H. Hobbs, Jr. and M. L. Jones, both of the Smithsonian Institution.

## Genus *Hermenia* Grube, 1856

*Type-species*: *H. verruculosa* Grube, 1856, by monotypy. Gender: feminine.

*Diagnosis*: Body short, subrectangular, segments 26. Elytra 12 pairs, on segments 2, 4, 5, 7, and on alternate segments to 23, with dorsal cirri on posterior 3 segments; elytra firmly attached to indistinct elytrophores; first 1–3 pairs moderately large, remaining ones very small (easily overlooked) to moderately so; elytra with fringes of short papillae and spiny macrotubercles. Prostomium bilobed, with 2 pairs of eyes, paired palps, and 3 antennae; lateral antennae inserted terminally on anterior continuations of prostomium, i.e., lepidonotoid. Tentacular segment (I) lateral to prostomium, with few notosetae, 2 pairs of tentacular cirri, and bulbous facial tubercle. Buccal segment (II) with ventral buccal cirri longer than those following and without distinct nuchal fold. Parapodia subbiramous; notopodia forming small lobes on anterodorsal faces of stout neuropodia; neuropodia truncate and papillate distally. Notosetae few to absent, slender, finely spinous. Neurosetae stout, with falcate tips and 1 or 2 stout teeth. Dorsal cirri with cylindrical cirrophores and rather short styles. Ventral cirri short, subulate. Pygidium with pair of anal cirri. Pharynx with 11 pairs of papillae (somewhat variable?) and 2 pairs of jaws. Nephridial papillae short, cylindrical, beginning on segments 6, 7, or 8. Integument tuberculate and/or papillate.

### Key to the Species of *Hermenia*

1. First 2 or 3 pairs of elytra moderately large; remaining ones smaller but none so small as to be easily overlooked (Fig. 4a–c). Both dorsal and ventral surfaces papillate, not tuberculate (Fig. 3a,c,d). Neurosetae with 2 stout accessory teeth (Fig. 3f) ..... *H. acantholepis* (Grube)

1′. First pair of elytra large; remaining ones very small, deeply embedded, and easily overlooked (Figs. 1a–c, 5a,c,d). Dorsal surface tuberculate (Figs. 1a, 5a) ..... 2

2. Neurosetae with single stout accessory tooth (Fig. 2h). Ventral surface densely papillate (Fig. 2f,g) ..... *H. verruculosa* Grube

2′. Neurosetae with 2 accessory teeth—one stout and one more slender (slender one sometimes missing; Fig. 6f). Ventral surface wrinkled, not thickly papillate (Fig. 6c,d) ..... *H. neoverruculosa* new species

*Hermenia verruculosa* Grube
Figures 1, 2

*Hermenia verruculosa* Grube, 1856: 44.—Treadwell, 1911: 9, figs. 23–26; 1924: 5; 1928: 452; 1939: 187, fig. 19.—Seidler, 1923: 261, fig. 6; 1924: 95.— Augener, 1925: 4; 1927: 43.—Hartman, 1939: 4.— Fauvel, 1953a: 4.—Bellan, 1964; 307.—Ebbs, 1966: 500, fig. 4, a–g.— Devaney, 1974: 122, 140.—Rullier, 1974: 19.
*Polynoe nodosa* Treadwell, 1901: 187, figs. 8,9. [Not Sars, 1861.]
*Lepidonotus verruculosus*.—Horst, 1922: 198.

*Material examined*: West Indies and Caribbean Sea: Virgin Islands: St. John, 9 June 1846, Krøyer, collector—holotype of *Hermenia verruculosa* (UZMC). Off St. Thomas 36.5–42 m, Fish Hawk sta. 6079, 6 February 1899—holotype of *Polynoe nodosa* (USNM 16013). St. James Island near St. Thomas, 4.5 m, 10 July 1915, C. R. Shoemaker, collector—1 specimen (USNM 46912). Virgin Islands, 91 m, S.S. Advance II, sta. 1, September 1970, J. Clark, collector—1 specimen (USNM 46922). Barbuda: near Spanish Point, shore, on beach wrack and coral, 28 April 1958, W. L. Schmitt, collector—1 specimen (USNM 46915). Barbados: 3 miles west of Needham Point, University of Iowa Barbados-Antigua Expedition—1 specimen (USNM 20272; reported by Treadwell, 1924). Puerto Rico: Fajardo, Fish Hawk 1898–99—paratype of *Polynoe nodosa* (USNM 16014). Majimo Reef, rather compact calcareous sand of Mangrove Island, 1–2 feet, 9 March 1967, M. E. Rice, collector—1 specimen (USNM 46920). Caribbean: 09°32′N, 79° 54′W, 62 m, Albatross sta. 2146, 2 April 1884—1 specimen (USNM 951). 18°30′N, 66°25′W, 73 m, Johnson-Smithsonian Deep Sea Expedition, 7 February 1933—1 specimen (USNM 20058). Bahamas: Golding Key, Andros Island, 13 May 1912, P. Bartsch, collector—1 specimen (USNM 16492). Off North Point, Gibson Cay, Andros Island, 24°19.8′N, 77°40.8′W, 6 March 1966, M. L. Jones, collector—1 specimen (USNM 46918). Outer reef, north of Clarencetown, Long Island, 15 May 1970, C. Riser, collector—1 specimen (USNM 46921).

Central and South America: British Honduras: on brittle star, *Ophiocoma pumila* Lütken, 7 March 1969, D. M. Devaney, collector—1 specimen (BPBM). Carrie-Bow Cay, 27 m, 11 June 1972, M. E. Rice, collector—2 specimens (USNM 50112). Colombia: Old Providence Island, shore, Presidential (Roosevelt) Cruise sta. 30, 6 August 1938, W. L. Schmitt, collector—1 specimen (USNM 20489; reported by Hartman, 1939)

Florida and Gulf of Mexico: Florida: Dry Tortugas, June–July 1914, A. L. Treadwell, collector—3 specimens (USNM 17722, 17733). Loggerhead Key, Dry Tortugas, A. L. Treadwell, collector, Fauvel collection—1 specimen (BMNH 1928: 4: 236). Dry Tortugas, 1930, W. L. Schmitt, collector—2 specimens (USNM 46913; BMNH 1972: 106). Loggerhead Key, from matrix of large brain coral, 3 m, 19 August 1966,

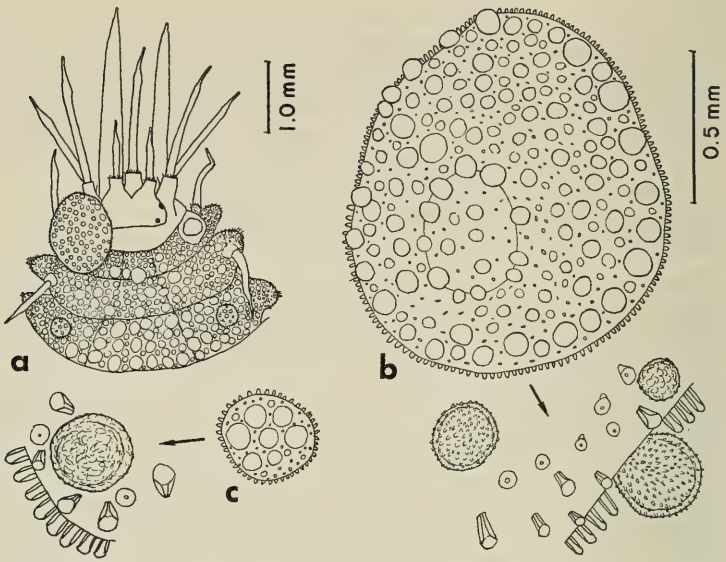



Fig. 1. *Hermenia verruculosa* (Paratype of *Polynoe nodosa* Treadwell, USNM 16014): a, Prostomium and anterior four segments, dorsal view; first right elytron removed; b, First elytron (segment II), with detail of tubercles and sensory papillae; c, Elytron from middle of body, with detail of tubercles and sensory papillae.

R. F. Cressey, collector—2 specimens (USNM 46919). Off Louisiana: 28°06′N, 91°02′W, 53 m, Oregon sta. 1416, 21 September 1955—1 specimen (USNM 46914). S.E. Mexico: Yucatán peninsula, Bahía de la Ascensión, Quintana Roo, Nicchehabin Reef, cracked from coral pieces and sea fans, 1–2 m, Smithsonian-Bredin Expedition, stations 67 and 72, 13/14 April 1960, W. L. Schmitt and E. L. Bousfield, collectors—2 specimens (USNM 46916–7).

North Atlantic: Off New Jersey, 39°56′N, 70°20′W, 223 meters, Albatross station 2246, 26 September 1884—1 specimen (USNM 3296).

*Description*: Length of holotype 20 mm, width including setae 8 mm, segments 26. Length of largest specimen from Tortugas (USNM 17733) 32 mm, width including setae 9 mm, segments 26. Body short, subrectangular, flattened ventrally, arched dorsally, slightly tapered anteriorly and posteriorly. First pair of elytra moderately large, nearly covering prostomium; following elytra very small, partially embedded in integument of body (easily overlooked; Figs. 1a–c, 2f). Elytra oval; margins with short, cylindrical, sensory papillae; surface with small, globular, sensory papillae and spiny, globular macrotubercles of various sizes.

Prostomium (Fig. 1a) bilobed; ceratophore of median antenna cylindrical, papillate, inserted in anterior notch; style long, smooth, with subterminal enlargement and filiform tip; lateral antennae similar to but shorter than median antenna; palps long, stout, tapered, smooth; anterior pair of eyes situated anterolaterally, larger than posterodorsal pair. Tentacular segment (I) distinct dorsally but sometimes retracted within segment II; parapodia lateral to prostomium, bearing 2 pairs of tentacular cirri, resembling median antenna, ventral pair slightly shorter than dorsal pair; few (1 or 2) notosetae on mesial side; bulbous facial tubercle projecting anteriorly on ventral upper lip.

Buccal segment (II) bearing first pair of elytra, subbiramous parapodia, and ventral buccal cirri similar to tentacular cirri (Figs. 1a, 2a). Third segment with first pair of dorsal cirri (Figs. 1a, 2d). Neurosetae of these two segments differing from those of following in being more slender, straight, and usually provided with more numerous accessory teeth (Fig. 2c,e).

Parapodia subbiramous (Fig. 2f,g). Notopodia represented by small bulbous acicular lobes on anterodorsal sides of neuropodia. Notosetae greatly reduced (0–1), slender, curved, tapering to acute tips, with numerous spinous rows (Fig. 2b). Neuropodia stout, thick, truncate and distally papillate, with upper distal part distinctly notched; its dorsal surface covered with globular tubercles and its ventral surface papillate. Neurosetae (about 10), stout, amber-colored, falcate, with single lateral stout tooth (Fig. 2h). Cirrophores of dorsal cirri stout, cylindrical, papillate; styles moderately short, smooth, with subterminal enlargements and filiform tips. Dorsal tubercles on cirrigerous segments inconspicuous. Ventral cirri short, subulate, smooth.

Pygidium with anus situated medial to parapodia of posterior segment and bearing pair of long anal cirri on distinct papillate cirrophores. Pharynx usually with 11 pairs of papillae (10/11 or 11/12) and 2 pairs of amber-colored jaws. Nephridial papillae short, cylindrical, beginning on segment 7 or 8 (Fig. 2g). Dorsal surface of body and parapodia covered with globular tubercles and covered ventrally with fine papillae (Figs. 1a, 2f,g).

*Biology*: In the Tortugas, *H. verruculosa* was observed by Treadwell (1911: 11) living in the interstices of coral rocks, and, when disturbed, moving into deeper crevices with considerable rapidity, clinging with great tenacity to the rock, and thus making it difficult to remove them without injury. In British Honduras, Devaney (1974: 122, 140) collected a specimen of *H. verruculosa* that was attached to the ophiuroid, *Ophiocoma pumila* Lütken. The two animals were both transversely banded, brown and white, and the dorsal papillae of the polynoid were similar in size and color to the granules of the disc of the ophiuroid, giving the worm a camouflaged appearance against the ophiuroid and suggesting a possible commensal relationship.

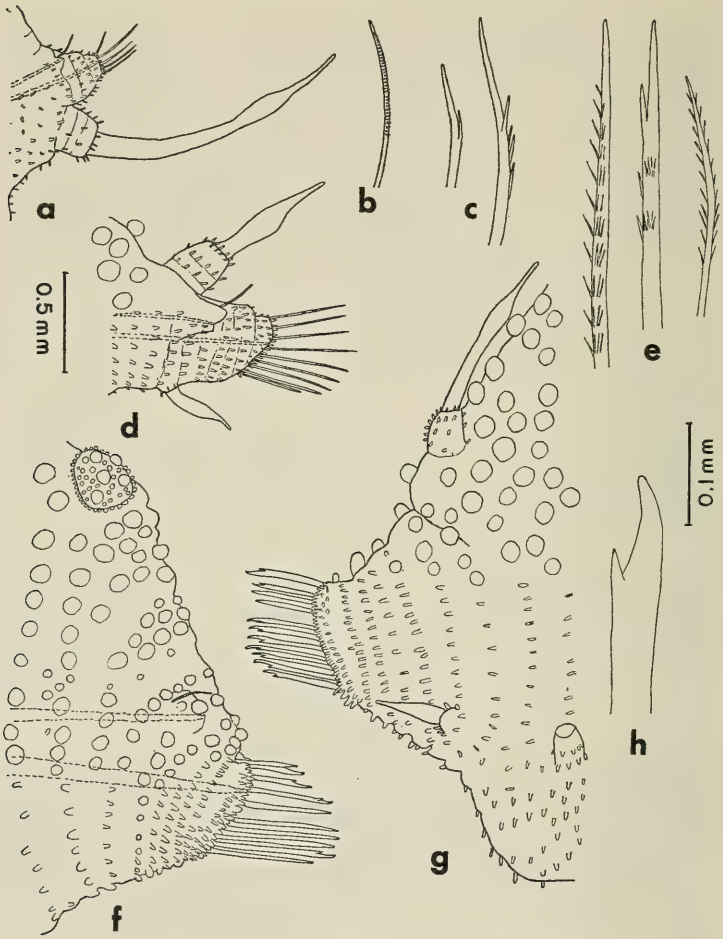



FIG. 2. *Hermenia verruculosa* (Paratype of *Polynoe nodosa* Treadwell, USNM 16014): a, Left parapodium from segment II, anterior view; internal acicula dotted; b, Notoseta from same; c, Two neurosetae from same; d, Left parapodium from segment III, anterior view; internal acicula dotted; e, Three neurosetae from same; f, Left elytragerous parapodium, anterior view; internal acicula dotted; g, Left cirrigerous parapodium, posterior view; h, Neuroseta.

*Distribution*: West Indies and Caribbean Sea, Bahamas, South and Central America (Colombia, British Honduras), Gulf of Mexico (S.W. Florida, off Louisiana, Yucatán Peninsula, Mexico), North Atlantic (off New Jersey). In low water to 223 m.

*Hermenia acantholepis* (Grube)
Figures 3, 4

*Polynoe acantholepis* Grube, 1876: 61.
*Polynoe* (*Lepidonotus*) *acantholepis*.—Grube, 1878: 24, pl. 2: Fig. 1.
*Lepidonotus acantholepis*.—Michaelsen, 1892: 95.—Hornell, 1903: 25.—Horst, 1917: 67, pl. 15: Figs. 3, 4.—Fauvel, 1922: 490, Fig. 1, a–d.
*Hermenia acantholepis*.—Seidler, 1923: 262; 1924: 94.—Monro, 1924: 39, Figs. 2, 3; 1939: 169.—Pruvot, 1930: 11, pl. 1. Figs. 27–32.—Fauvel, 1933: 41; 1935: 296; 1953b: 38, Fig. 14,a,b.

*Material examined*: Japan, Goto Island—2 specimens (BMNH 1925: 1: 28: 4–5; reported by Monro, 1924).

Philippine Islands, Upolu—holotype of *Polynoe acantholepis* (ZMH 504).

Indonesia (reported by Horst, 1917): Bay of Badjo, west coast of Flores, shore, Siboga sta. 50—1 specimen (ZMA 547a). Anchorage off Pasir Pandjang, west coast of Binongka, reef, sta. 220—2 specimens (ZMA 547b; RMNHL 1124). Nalahia Bay, Nusa Laut Island, reef, sta. 234—1 specimen (RMNHL 1125). South coast of Timor, 08°39.1'S, 127°04.4'E, 34 m, *Lithothamnion*, sta. 285—1 specimen (ZMA 547c).

Annam, Honlohé, Île Mamelles, Fauvel collection—1 specimen (MNHNP; reported by Fauvel, 1935).

Ceylon, Driesch, collector—2 specimens (ZMH 505; reported by Michaelsen, 1892). Ceylon, Talili Bay, 73 m, Willey collection—1 specimen (BMNH 1973: 12: reported by Hornell, 1903).

Maldives, Felidu, J. S. Gardiner, collector—1 specimen (BMNH 1941: 4: 4: 195; reported by Monro, 1939).

*Description*: Length of holotype 25 mm, width including setae 8 mm, segments 26. Length of two specimens from Siboga stations 220 and 234 (RMNHL 1124/5) 13–25 mm, width including setae 6–9 mm, segments 26. Length of specimen from New Caledonia, according to Pruvot (1930: 11), 33 mm, width including setae 10 mm, segments 26. Body short, subrectangular, flattened ventrally, arched dorsally, tapered slightly anteriorly and posteriorly.

First 2–3 pairs of elytra moderately large, touching medially; following elytra smaller (not so small as in *H. verruculosa*; Figs. 3d, 4a–c). Elytra rounded to oval; margins and surfaces with short cylindrical sensory papillae and globular to oval spinuous macrotubercles of various sizes.

Prostomium (Fig. 3a) bilobed; ceratophore of median antenna cylindrical, distally papillate, inserted in anterior notch; style long, smooth, with subterminal enlargement and filiform tip; lateral antennae similar to and slightly shorter than median antenna; palps long, stout, tapered, smooth; anterior pair of eyes situated anterolaterally, slightly larger than posterodorsal pair; prostomium often partly withdrawn, resulting in posterior pair of eyes being hidden from view by fold of segment II.

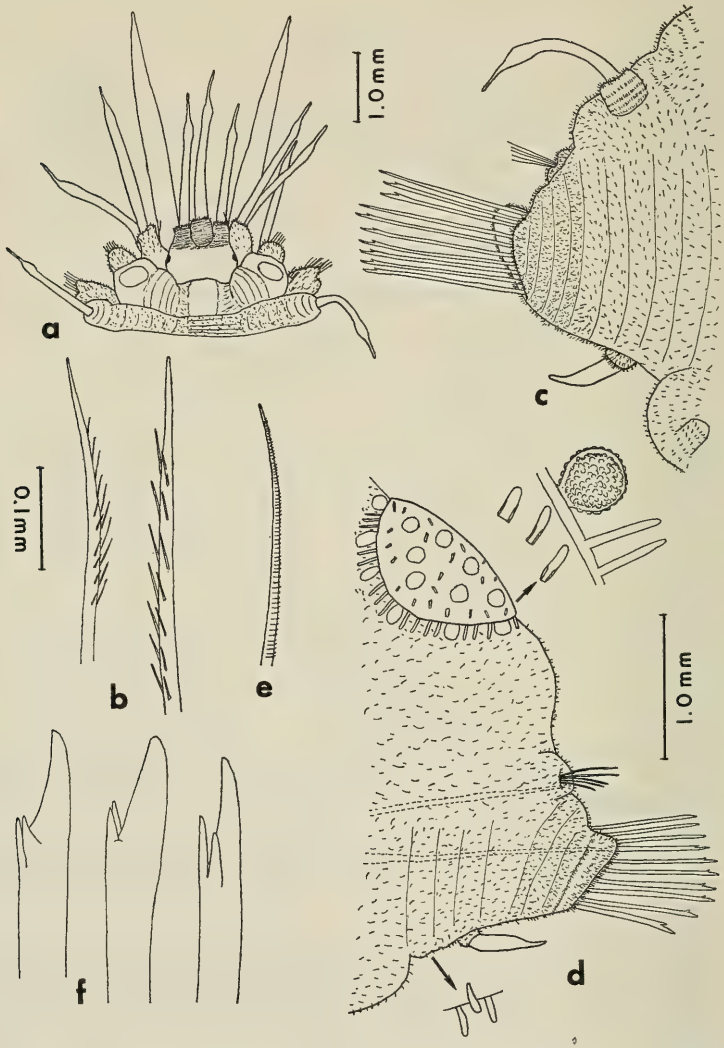



FIG. 3. *Hermenia acantholepis* (ZMA 547b): a, Prostomium and anterior three segments, dorsal view; elytra removed; prostomium partly withdrawn, resulting in posterior pair of eyes being hidden from view by fold of segment II; b, Two neurosetae from segment II; c, Left cirrigerous parapodium, posterior view; d, Left elytragerous parapodium, anterior view, with detail of elytral tubercles and papillae and neuropodial papillae; internal acicula dotted; e, Notoseta; f, Three neurosetae.

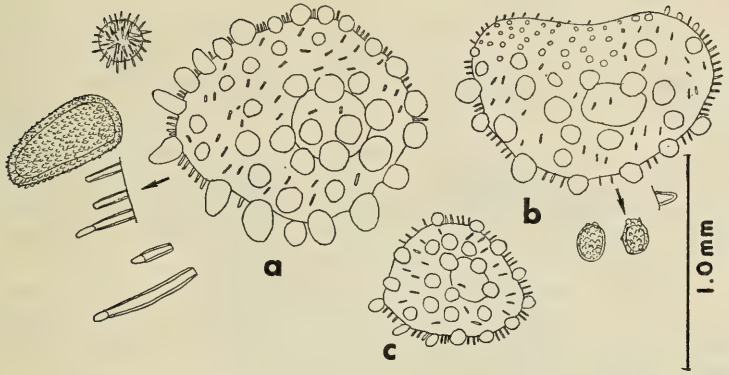



Fig. 4. *Hermenia acantholepis* (from Annam, MNHNP): a, First right elytron (segment II), with detail of tubercles and papillae; b, Second right elytron (segment III); c, Middle right elytron.

Parapodia of tentacular segment (I) lateral to prostomium and bearing 2 pairs of tentacular cirri resembling median antenna; ventral pair slightly shorter than dorsal pair; few (1–2) notosetae on mesial side; bulbous facial tubercle projecting anteriorly on ventral upper lip.

Buccal segment (II) bearing first pair of elytra, subbiramous parapodia, and ventral buccal cirri similar to tentacular cirri. Neurosetae of segments II and III differing from those of following in being more slender, straight, and provided with more numerous accessory teeth (Fig. 3b).

Parapodia subbiramous (Fig. 3c,d). Notopodia forming small bulbous, papillate acicular lobes on anterodorsal sides of neuropodia. Notosetae few in number, slender, curved, tapering to blunt tips, with numerous spinous rows (Fig. 3e). Neuropodia stout, thick, papillate, with diagonally truncate presetal acicular lobes and shorter, rounded postsetal ones. Neurosetae (about 18), stout, amber-colored, slightly falcate, with pair of large conical teeth (Fig. 3f). Cirrophores of dorsal cirri stout, cylindrical, papillate; styles relatively short, smooth, with subterminal enlargements and filiform tips. Dorsal tubercles on cirrigerous segments inconspicuous. Ventral cirri short, subulate, smooth.

Pygidium with anus situated medial to parapodia of posterior segment and bearing pair of long anal cirri on distinct papillated cirrophores. Pharynx not extended. Nephridial papillae short, cylindrical, beginning on segment 6 (Fig. 3c). Body thickly covered with short cylindrical papillae (Fig. 3a,c,d).

*Distribution*: Widely distributed in Indo-Pacific Region: Japan (Goto Island, Seto), Indochina, Philippines, Indonesia, Australia (Pelsart group), New Caledonia, Ceylon, Maldives, Madagascar, Gulf of Suez. Intertidal to 73 m.

**Hermenia neoverruculosa** new species
Figures 5, 6

*Hermenia verruculosa.*—Monro, 1924: 40; 1939: 169, fig. 2. [Not Grube, 1856].

*Material examined*: Indian Ocean: Cargados, Carajos, 55 m, Sealark, 28 August 1905, Gardiner, collector—holotype (BMNH 1941: 4: 4: 197). Seychelles, 68 m, Sealark, 30 October 1905, Gardiner, collector—paratype (BMNH 1941: 4: 4: 196). Darros Island, the Amirantes, H.M.S. "Alert"—1 specimen (BMNH 1925: 1: 28: 6).

*Description*: Length of holotype 29 mm, width including setae 8 mm, segments 26. Length of paratype 22 mm, width including setae 7 mm, segments 26. Body short, subrectangular, flattened ventrally, arched dorsally, tapered slightly anteriorly and posteriorly.

First pair of elytra large, covering prostomium; following elytra very small (Figs. 5a,c,d; 6d). Elytra oval; margins with short cylindrical papillae; surface with short, globular, sensory papillae and globular to oval, spiny macrotubercles of various sizes.

Prostomium (Fig. 5a, b) bilobed; ceratophore of median antenna cylindrical, somewhat wrinkled or annulate, inserted in anterior notch; style long, with subterminal enlargement and filiform tip, smooth; lateral antennae similar to but shorter than median antenna; palps missing; anterior pair of eyes situated anterolaterally, subequal in size to posterolateral pair. Tentacular segment (I) dorsally distinct, forming inflated area medial to elytrophores of segment II; parapodia lateral to prostomium, bearing 2 pairs of tentacular cirri resembling median antenna; single notoseta on mesial side; bulbous facial tubercle projecting anteriorly on ventral upper lip (Fig. 5a,b).

Buccal segment (II) bearing first pair of elytra, subbiramous parapodia, and ventral buccal cirri similar to tentacular cirri (Figs, 5a,b; 6a). Neurosetae few in number (some lost?), differing from those of following in being more slender, curved, and provided with few spinous rows (Fig. 6b).

Parapodia subbiramous (Fig. 6c,d). Notopodia forming small subconical acicular lobes on anterdorsal sides of neuropodia. Notosetae greatly reduced (0–2), slender, curved, tapering to blunt tips, with numerous spinous rows (Fig. 6e). Neuropodia stout, thick, truncate and distally papillate, upper distal part distinctly notched. Neurosetae (about 12), stout, amber-colored, slightly falcate, with 2 teeth—one stouter and one more slender, latter one sometimes missing (Fig. 6f). Cirrophores of dorsal cirri stout, cylindrical; styles relatively short, smooth, with subterminal enlargements and filiform tips. Dorsal tubercles on cirrigerous segments inconspicuous. Ventral cirri short, subulate, smooth.

Pygidium with anus situated medial to parapodia of posterior segment and bearing pair of long anal cirri on distinct cirrophores. Pharynx not extended. Nephridial papillae short, cylindrical, beginning on segment 7. Dorsal surface of body covered with globular tubercles; ventral

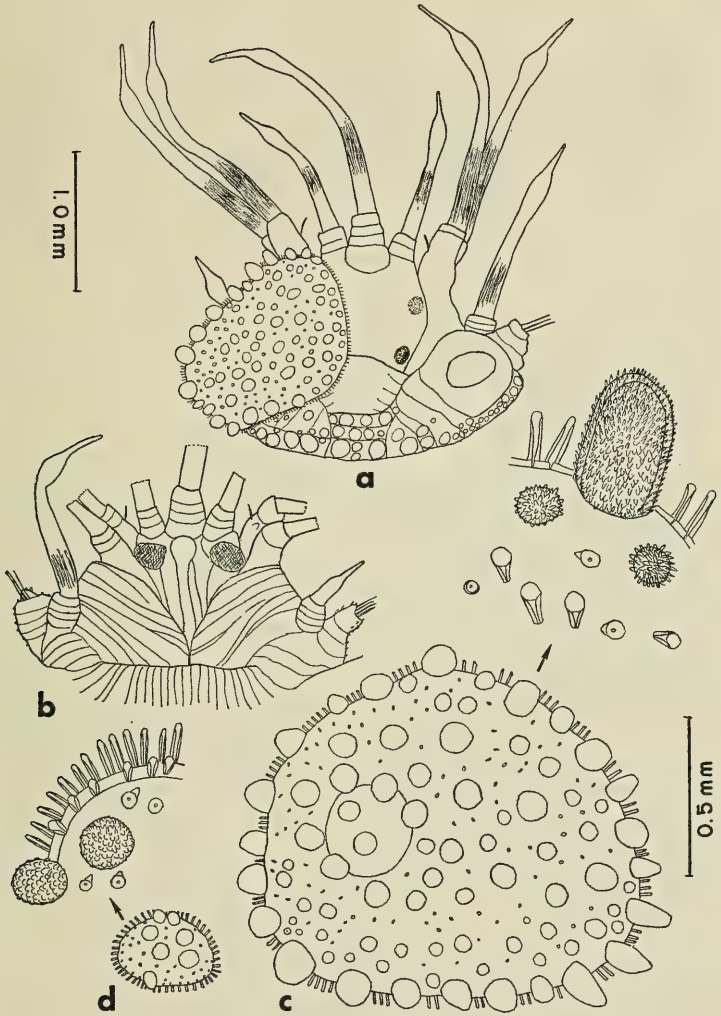



Fig. 5. *Hermenia neoverruculosa* (Holotype, BMNH 1941: 4: 4: 197): a, Dorsal view of prostomium and anterior two segments, palps missing; right elytron removed; left buccal cirrus smaller, regenerating; b, Same, ventral view; position of missing palps cross-hatched; c, First right elytron, with detail of tubercles and papillae; d, Elytron from middle of body, with detail of tubercles and papillae.

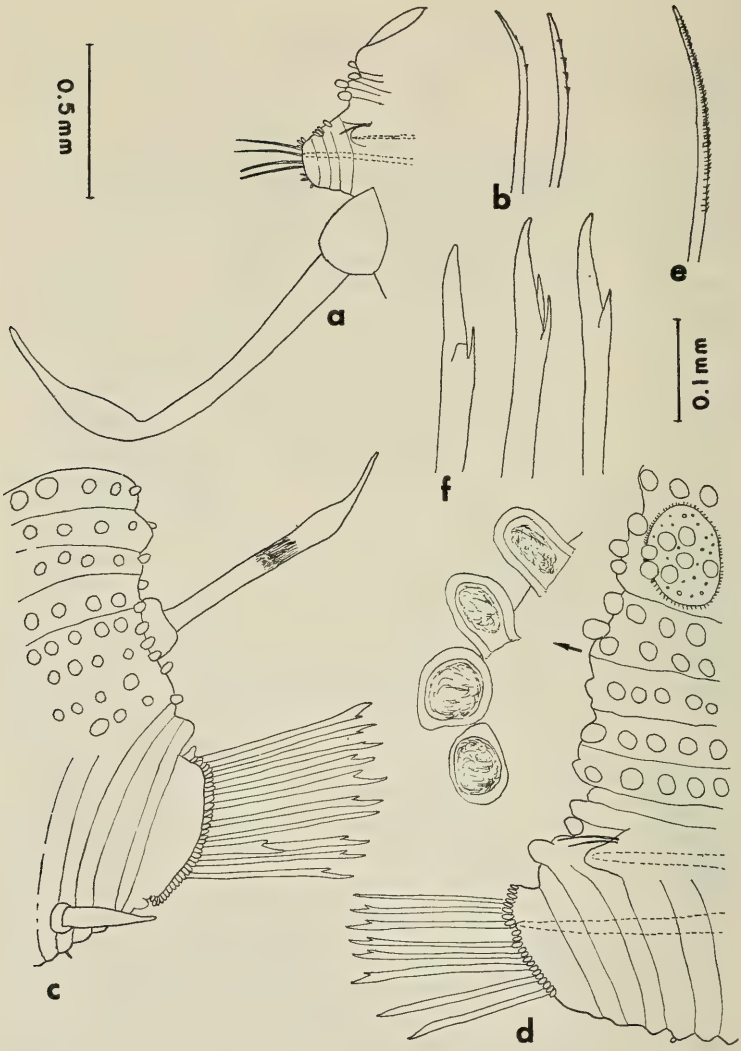



Fig. 6. *Hermenia neoverruculosa* (Holotype, BMNH 1941: 4: 4: 197): a, Right parapodium from segment II, anterior view; internal acicula dotted; b, Two neurosetae from same (tips broken); c, Right cirrigerous parapodium, posterior view; d, Right elytragerous parapodium, anterior view, with detail of tubercles from dorsal surface; internal acicula dotted; e, Notoseta; f, Three neurosetae.

surface and parapodia wrinkled, with only few scattered small papillae (Figs. 5a,b; 6c,d).

*Remarks*: In many respects, *H. neoverruculosa* is intermediate between *H. verruculosa* and *H. acantholepis*, as indicated in the key to the species above. It lies within the geographic range of the widely distributed Indo-Pacific *H. acantholepis* but appears to resemble more closely the Caribbean *H. verruculosa*, as indicated by Monro (1924, 1939), when he referred the specimens from the Indian Ocean, with some hesitancy, to *H. verruculosa*.

*Distribution*: Indian Ocean. Intertidal to 68 m.

## Literature Cited


Augener, H. 1925. Über Westindische und einige andere Polychaetentypen von Grube (Oersted), Krøyer, Mörch und Schmarda. Publ. Univ. Zool. Mus. København No. 39:1–47, 3 figs.

———. 1927. Polychaeten von Curaçao. Bijdragen tot de Dierkunde, Amsterdam 25:39–82, 9 figs.

Bellan, G. 1964. Campagne de la *Calypso* dans l'Atlantique. Annélides polychètes. Ann. Inst. Oceanogr. N.S. 41:301–314, 1 fig.

Devaney, D. M. 1974. Shallow-water echinoderms from British Honduras, with a description of a new species of *Ophiocoma* (Ophiuroidea). Bull. Mar. Sci. 24(1):122–164, 16 figs.

Ebbs, N. K., Jr. 1966. The coral-inhabiting polychaetes of the northern Florida reef tract. Part 1. Aphroditidae, Polynoidae, Amphinomidae, Eunicidae, and Lysaretidae. Bull. Mar. Sci. 16:485–555, 12 figs.

Fauvel, P. 1922. Annélides polychètes de l'Archipel Houtman Abrolhol (Australie occidentale) recueillies par M. le Professeur W. G. Dakin, F.L.S. J. Linn. Soc. London 34:487–500, 2 figs.

———. 1933. Mission Robert Ph. Dollfus en Égypte. Annélides polychètes. Mémoires présentés a l'institut d'Égypte et publiés sous les auspices sa Majesté Fouad I$^{er}$, Roi d'Egypte 21:31–83, 6 figs.

———. 1935. Annélides polychètes de l'Annam. Mem. Pont. Accad. Sci. Nuovi Lincei ser. 3, 3:279–354, 18 figs.

———. 1953a. Annélides polychètes de la Croisiere du "President Theodore Tissier" aux Antilles (1951). Bull. Inst. Océanog. Monaco No. 1033:1–23.

———. 1953b. Annelida Polychaeta. The Fauna of India including Pakistan, Ceylon, Burma and Malaya. Allahabad, The Indian Press. 1–507, 250 figs.

Grube, E. 1856. Annulata Örstediana. Enumeratio Annulatorum, quae in itinere per Indiam occidentalem et Americam centralem annis 1845–1848 suspepto legit cl. A. S. Örsted, adjectis speciebus nonnullis a cl. H. Kröyero in itinere ad Americam meridionalem

collectis. Vidensk. Meddl. naturh. Foren. Kjobenhavn 1856: 44–62.

———. 1876. Bemerkungen über die Famillie der Aphroditeen (Gruppe Polyonina, Acoëtea, Polylepidea). Jahresber. Schles. Gesells. Vaterl. Kultur, Breslau, vol. for 1875: 46–72.

———. 1878. Annulata Semperiana. Mém. Acad. Imp. Sci. St. Pétersbourg ser. 7, 25(8):1–300, 15 pls.

Hartman, O. 1939. The polychaetous annelids collected by the Presidential Cruise of 1938. Smithsonian Misc. Coll. 98:1–22, 3 figs.

Hornell, J. 1903. *In* Herdman, W. A. Report to the Government of Ceylon on the Pearl Fisheries of the Gulf of Manaar, with Supplementary Reports upon the Marine Biology of Ceylon by other Naturalists, Pt. 1:1–97.

Horst, R. 1917. Polychaeta errantia of the *Siboga*-Expedition. Pt. 2. Aphroditidae and Chrysopetalidae. *Siboga*-Exped. Leyden 24b: 1–140, 5 figs., pls. 11–29.

———. 1922. On some polychaetous annelids from Curaçao. Bijdragen tot de Dierkunde Amsterdam. Feest-nummer: 193–201, 2 figs.

Michaelsen, W. 1892. Polychaeten von Ceylon. Jahrb. Hamburg. wiss. Anstalten 9(2):93–113, 18 figs.

Monro, C. C. A. 1924. On the Polychaeta collected by H.M.S. 'Alert,' 1881–1882. Families Polynoidae, Sigalionidae, and Eunicidae. Jour. Linn. Soc. Zool. 36:37–64, 24 figs.

———. 1939. On some tropical polychaetes in the British Museum mostly collected by Dr. C. Crossland at Zanzibar, Tahiti, and the Marquesas. I. Families Amphinomidae to Phyllodocidae. Ann. Mag. Nat. Hist. ser. 11, 4:161–184, 7 figs.

Pruvot, G. 1930. Annélides polychètes de Nouvelle-Calédonie recueillies par M. François. Arch. Zool. Exp. Gen. Paris 70:1–94, 8 figs., 3 pls.

Rullier, F. 1974. Quelques annélides polychètes de Cuba recueillies dans les éponges. Trav. Mus. Hist. Nat. "Gr. Antipa" 14:9–77, 9 figs.

Seidler, H. F. 1923. Über neue und wenig bekannt Polychäten. Zool. Anz. Leipzig 56:254–264, 8 figs.

———. 1924. Beiträge zur Kenntnis der Polynoiden, I. Arch. Naturg. 89A (11):1–217, 22 figs., 2 pls.

Treadwell, A. L. 1901. The polychaetous annelids of Porto Rico. Bull. U.S. Fish Comm. Washington, Bull. for 1900 2:181–201, 81 figs.

———. 1911. Polychaetous annelids from the Dry Tortugas, Florida. Bull. Amer. Mus., Nat. Hist., N.Y. 30:1–12, 29 figs.

———. 1924. Polychaetous annelids, collected by the Barbados-Antigua Expedition from the University of Iowa in 1918. Univ. Iowa Stud. 10(4):1–23, 2 pls.

———. 1928. Polychaetous annelids from the Arcturus Oceanographic Expedition. Zoologica, N.Y. 8:449–485, figs. 177–179.
———. 1939. Polychaetous annelids of Porto Rico and vicinity. Scientific Survey of Porto Rico and the Virgin Islands. N. Y. Acad. Sci. 16(2):151–319, 118 figs.

73

No. 23, pp. 249–252 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SMITHSONIAN INSTITUTION
AUG 27 1975

# *EURYSQUILLA PACIFICA*, A NEW STOMATOPOD CRUSTACEAN FROM NEW BRITAIN

By Raymond B. Manning
*Smithsonian Institution, Washington, D.C. 20560*

Among the unidentified stomatopods examined in the collection of the Zoological Museum, Berlin, in 1971, was a small gonodactylid which proved to be the first species of *Eurysquilla* to be identified in the central Pacific and only the second species to be found in the Indo-West Pacific region. This species is described below.

Studies of Indo-West Pacific stomatopods have been supported by the Smithsonian Institution through its Research Awards Program. I thank Dr. G. Hartwich of the Zoological Museum, Berlin, for providing working space there in 1971 and for the loan of this specimen. The illustrations were prepared by my wife Lilly.

**Eurysquilla pacifica,** new species
Figure 1

*Holotype*: 1♀, total length 17 mm; Ralum, New Britain; F. Dahl, col., 1896; ZMB 18097.

*Description*: Cornea broadened, faintly bilobed, set obliquely on stalk. Eyes extending beyond end of second segment of antennular peduncle. Ocular scales low, appearing fused in midline, produced laterally. Anterior margin of ophthalmic somite unarmed.

Antennular peduncle shorter than carapace. Antennular processes produced into slender spines directed anterolaterally.

Antennal scale short, less than half as long as carapace. Antennal protopod with 1 ventral papilla.

Rostral plate cordiform, broader than long, rounded anterolateral margins converging on obtusely pointed apex.

Carapace smooth, strongly narrowed anteriorly, anterior parts of lateral plates projecting slightly beyond base of rostral plate.

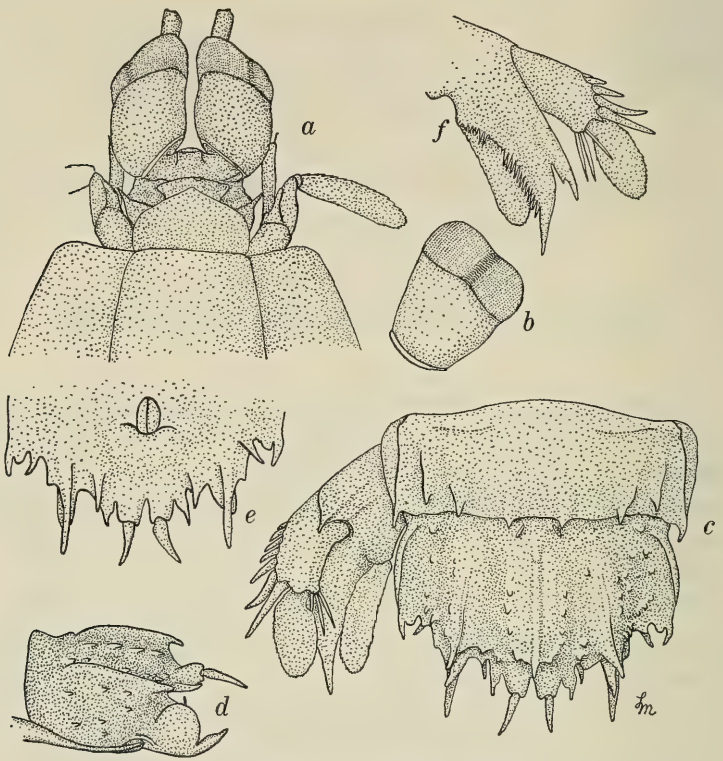



FIG. 1. *Eurysquilla pacifica*, new species, female holotype, TL 17 mm: *a*, Anterior part of body; *b*, Eye; *c*, Sixth abdominal somite, telson, and uropod, dorsal view; *d*, Telson, lateral view; *e*, Telson, ventral view; *f*, Uropod, ventral view. Setae omitted in all figures.

Raptorial claws missing.

Mandibular palp and 5 epipods present, third to fifth very small.

Exposed thoracic somites lacking carinae or spines. Fifth thoracic somite lacking distinct lateral process or ventrolateral spine. Lateral processes of sixth and seventh thoracic somites rounded anteriorly and posteriorly, that of sixth somite smaller, more truncate laterally. Eighth thoracic somite lacking distinct median ventral tubercle. Endopods of walking legs slender, two-segmented. Basal segments of walking legs unarmed.

Anterior 4 abdominal somites smooth, lacking carinae or spines. Fifth somite with low, unarmed longitudinal carina above lateral margin. Sixth somite with 4 pairs of spines: submedians on margin, lacking

sharp dorsal carina; intermediates submarginal, with short dorsal carina; accessory spine on longer carina present between intermediates and laterals, latter on normal sharp lateral carina. Sixth somite with obtuse lobe ventrally in front of articulation of each uropod.

Telson broader than long, with entire median and dorsal submedian carinae, each terminating in long spine. Accessory median carinae each a row of 4–5 tubercles converging under apical spine of median carina. Tubercles present on each side of submedian carina, in a line mesially, in a patch laterally. Three pairs of marginal spines present: submedians, with bases appressed and long, movable apices; intermediates, each with large, rounded, dorsally-projecting dorsal lobe and low lobe on outer margin; and marginals, with smaller, rounded lobe on inner margin. Submedian denticles absent; 2 intermediate denticles present, inner with apical spinule, outer triangular, with submarginal spinule; lateral denticle with submarginal spinule.

Uropod with 7 movable spines on outer margin of proximal segment of exopod, distalmost extending beyond midlength of distal segment; inner distal angle of proximal segment with 3 stiff setae. Basal prolongation of uropod broad, terminating in 2 spines, inner much the longer, with 20–22 sharp spinules on inner margin; outer spine of basal prolongation with slender spinule on inner margin.

Color pattern completely faded.

*Measurements*: Female only known, total length 17 mm. Other measurements, in mm: carapace length 2.8; cornea width 1.1; rostral plate length, width 0.7, 1.1; antennal scale length 1.2; antennular peduncle length 1.7; fifth abdominal somite width 3.4; telson length, width 1.6, 2.8.

*Discussion*: *Eurysquilla pacifica*, only the second species of the genus to be found in the Indo-West Pacific region, differs from *E. sewelli* (Chopra, 1939) from the Gulf of Aden as well as from 3 American species, *E. plumata* (Bigelow, 1901), *E. veleronis* (Schmitt, 1940), and *E. delsolari* Manning, 1970, in having a broad rather than a very long slender basal prolongation of the uropod; in those 4 species the basal prolongation is Y-shaped and has at most 1 additional spine or lobe on its inner margin. *E. pacifica* resembles 3 western Atlantic species, *E. maiaguesensis* (Bigelow, 1901), *E. chacei* Manning, 1969, and *E. holthuisi* Manning, 1969, in having a broad basal prolongation with 5 or more spinules on the inner margin. The new species differs from *E. maiaguesensis* in having a mandibular palp, 8 rather than 6 posterior spines on the sixth abdominal somite, more dorsal tubercles on the telson, and a spinule rather than an obtuse lobe between the spines of the basal prolongation of the uropod. *E. pacifica* differs from *E. chacei* in having armed carinae on the fifth abdominal somite; only 1 pair of marginal spines on the sixth abdominal somite; fewer tubercles in the accessory median row on the telson, and, on the basal prolongation of the uropod, 20–22 rather than 10 slender spinules on the inner margin

and a spinule rather than a rounded lobe between the apical spines. *E. pacifica* and *E. chacei* are the only species in this section of the genus in which the sixth abdominal somite is armed posteriorly with 8 spines; in *E. chacei* the accessory spine is between the submedian and the intermediate on each side, whereas in *E. pacifica* it is between the intermediate and lateral spines. The new species differs from *E. holthuisi* in having rounded posterolateral angles on the lateral processes of the sixth and seventh thoracic somites, 8 rather than 6 posterior spines on the sixth abdominal somite, more dorsal tubercles on the telson (*E. holthuisi* lacks the accessory median row), and, on the basal prolongation of the uropod 20–22 rather than 10–12 inner spines, and a spinule rather than a rounded lobe between the apical spines.

All 3 of the similar western Atlantic species have a sharp apical spine on the rostral plate. The unique specimen of *E. pacifica* is young, and older specimens may well have an apical spine on the rostral plate.

The specific name alludes to the occurrence of the species in the central Pacific ocean.

## Literature Cited

Bigelow, R. P. 1901. The Stomatopoda of Puerto Rico. Bull. U.S. Fish Comm. 20(2):149–160, figs. 1–13.

Chopra, B. 1939. Stomatopoda. The John Murray Expedition, Sci. Reps. 6(3):137–181, figs. 1–13.

Manning, Raymond B. 1969. Stomatopod Crustacea of the western Atlantic. Stud. trop. Oceanogr. Miami 8: viii + 380, figs. 1–91.

———. 1970. Nine new American stomatopod crustaceans. Proc. Biol. Soc. Washington 83(8):99–144, figs. 1–9.

Schmitt, Waldo L. 1940. The stomatopods of the west coast of America based on collections made by the Allan Hancock Expeditions, 1933–1938. Allan Hancock Found. Pacif. Exped. 5(4):129–225, figs. 1–33.

3

QH
1
B4X
NH

No. 24, pp. 253–262 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES AUG 2 1975

# TWO NEW SPECIES OF THE INDO-WEST PACIFIC GENUS *CHORISQUILLA* (CRUSTACEA, STOMATOPODA), WITH NOTES ON *C. EXCAVATA* (MIERS)

By Raymond B. Manning
*Smithsonian Institution, Washington, D.C. 20560*

In 1972 I visited the Zoological Survey of India (Indian Museum), Calcutta, to study their extensive collection of types and other specimens of Indo-West Pacific stomatopods. Among the materials examined were 3 lots from the Andaman Islands that had been identified by Kemp (1913) with *Gonodactylus excavatus* Miers, 1880, the type-species of *Chorisquilla*. Earlier I had examined material from several Indo-Malayan localities in the Zoological Museum, Amsterdam that had been identified with the same species by Hansen (1926) and Holthuis (1941), and I had noted discrepancies in the published accounts of the species. In April 1973 I studied the holotype of *C. excavatus*, from an unknown locality, and additional specimens from the South China Sea that had been identified with that species by Pocock (1893) in the collection of the British Museum (Natural History). The specimens reported by Kemp proved to be a new species and those reported by Pocock, Hansen, and Holthuis represent a second new species. These two new species are described below, and a brief description of the unique type of *C. excavata* is included.

In the descriptions given below, particular attention is given to characters afforded by the sixth abdominal somite and telson. Except for those parts of the body, all of the species of *Chorisquilla* are very similar. Characteristics of the genus were summarized in an earlier paper (Manning, 1969).

Studies on Indo-West Pacific stomatopods have been supported by the Smithsonian Institution through its Research Award and Foreign Currency Programs. I thank K. K. Tiwari and H. C. Ghosh, Zoological Survey of India (IM), for providing working space and assistance in 1972 as well as for a subsequent exchange of material; and R. W. Ingle, British Museum (Natural History) (BMNH), and J. Stock, Zoological Museum, Amsterdam (ZMA), for providing working space and for the loan of specimens. Figures 1 and 2 were prepared by my wife Lilly.

*Chorisquilla excavata* (Miers, 1880)
Figure 1*a–b*

*Gonodactylus excavatus* Miers, 1880: 123, pl. 3, figs. 11–12.
*Protosquilla excavata.*—Brooks, 1886: 78 (listed; diagnosis from Miers, 1880).
not *Gondactylus excavatus.*—Gravier, 1937: 209, fig. 23.—Serène 1939: 349 (discussion).—Dawydoff, 1952: 145, 146 (discussion).—Serène, 1953: 507; 1954: 53 (discussion) (= *Haptosquilla glyptocercus* (Wood-Mason)).

*Material*: Locality unknown; holotype, 1 ♂, total length (TL) 19 mm; BMNH 75.14.

*Diagnosis*: Sixth abdominal somite (Fig. 1*a*) with 6 longitudinal bosses, submedians and intermediates unarmed, intermediates irregular in shape. Posterolateral angles of sixth abdominal somite forming sharp spines. Telson (Fig. 1*a*) slightly broader than long, with 5 smooth longitudinal bosses dorsally. Median boss (Fig. 1*a*) tapering posteriorly, extending almost to median cleft in posterior margin. Submedian bosses smooth, terminating at base of submedian marginal tooth. Marginal bosses smooth, extending to apex of intermediate teeth. Lateral margins of dorsal bosses smooth, lacking any trace of vertical furrows characteristic of *C. pococki*, new species and *C. andamanica*, new species. Marginal teeth of telson well separated, with broad but sharp apices; submedians with movable apices arising submarginally. 7 pairs of submedian (Fig. 1*a*) and 2 pairs of intermediate denticles present.

*Remarks*: *Chorisquilla excavata* differs from both *C. pococki*, new species and *C. andamanica*, new species in several characters: there are smoother bosses on the sixth abdominal somite and telson; the median boss of the telson extends almost to the anterior edge of the median incision in the telson margin; the apices of the marginal teeth of the telson are sharp; and there are only 7 pairs of submedian denticles. It further differs from *C. andamanica* in having sharp posterolateral spines on the sixth abdominal somite.

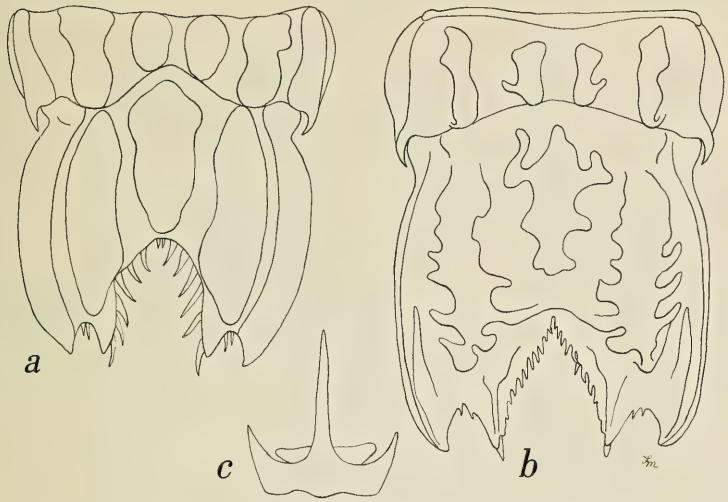



Fig. 1. *Chorisquilla excavata* (Miers), ♂ holotype: *a*, Outline of sixth abdominal somite and telson; *c*, Outline of rostral plate and ocular scales. *Chorisquilla pococki*, new species, ♂ paratype, Siboga sta. 133: *b*, Outline of sixth abdominal somite and telson. (Setae omitted).

Miers (1880, p. 123) clearly described the smooth longitudinal bosses on the telson which are shown in his illustration of the telson (pl. 3 fig. 12); however, his illustration was inaccurate in showing the intermediate marginal teeth of the telson extending well beyond the submedians. A camera lucida sketch of the telson of the holotype is given here (Fig. 1*a*); the marginal teeth, separated by a deep incision, extend to the same level.

The male holotype is now preserved dry; it could not be measured in detail. The type-locality is unknown. The specimen was among materials collected during the voyage of H.M.S. "Herald." Other material collected by the "Herald" and reported by Miers was from Bau, British Solomon Islands; Matuka and Conway Reef, Fiji Islands; and Shark's Bay, Western Australia. Presumably the species lives in the southwestern Pacific Ocean, but its range is unknown.

The specimens from Viet Nam reported and figured by Gravier (1937) are identifiable with *Haptosquilla glyptocercus* (Wood-Mason), as indicated by Serène (1954, p. 53). Inasmuch as Serène (1954, p. 6) did not include this species in his list of stomatopods from Viet Nam, it seems likely other earlier records of *C. excavata* from Viet Nam (Serène, 1939, 1953; Dawydoff, 1952) are based on Gravier's erroneous identification.

**Chorisquilla pococki,** new species
Figures 1*b*, 2

*Gonodactylus excavatus*.—Pocock, 1893: 476.—Odhner, 1923: 15.—Hansen, 1926, 36, pl. 2, fig. 4a.—Holthuis, 1941, 290.

*Material*: Macclesfield Bank, South China Sea; ♂ holotype, total length (TL) 17 mm; ♂ paratype, TL 12 mm; BM(NH) 92.8–28.9–10.—Same; ♀ paratype, TL 18 mm; BM(NH) 93.11.3.153.—Off Ampenan, west coast of Lombok, Indonesia; 13 fms (24 m); Van de Sande, col.; May 1909; ♂ paratype, TL 34 mm; ZMA.—Anchorage off Lirung, Salibabu Island, Talaud Islands, Indonesia; to 36 m; mud and hard sand; "Siboga" sta. 133; ♂ paratype, TL 14 mm; ZMA.—Anchorage between Nusa Besi (Ilhea de Jaco), and the northeast point of Timor, Portuguese Timor; 08°25.2′S, 127°18.4′E; 27–54 m; sand, coral and lithothamnion; "Siboga" sta. 282; ♂ paratype, TL 15 mm; ZMA.

*Diagnosis*: Fifth abdominal somite (Fig. 2*b*) smooth dorsally, with acute or sharply-spined posterolateral angles and 3 longitudinal grooves above margin. Sixth abdominal somite (Figs. 1*b*, 2*b*) with 3 pairs of dorsal bosses, submedians and intermediates unarmed, smooth dorsally, with irregular, eroded margins; lateral bosses smoother, each terminating in sharp posterolateral spine. Telson (Figs. 1*b*, 2*b*) length and width subequal (length greater in some specimens, width in others), appearing elongate, with 5 prominent longitudinal bosses on dorsal surface, smooth dorsally, margins of median and submedians very irregular, eroded. Median boss of telson not extending to anterior margin of median incision in telson. Submedian bosses (Figs. 1*b*, 2*b*) extending almost to bases of submedian teeth, posteriorly with transverse ridge extending to midline behind apex of median boss. Marginal bosses smooth, rounded dorsally, not furrowed laterally or mesially. Telson with 2 pairs of marginal teeth, apices well-separated by intermediate incision. Submedian teeth with distinct, sharp dorsal carina in small specimens, carina obscure in larger examples, apices of submedian teeth sharper than those of intermediates; submedian teeth each with movable submarginal spine. Broad intermediate tooth fusing with marginal carina in adults. 7–12 slender submedian denticles (Figs. 1*b*, 2*b*), fewer in larger specimens, and 2 intermediate denticles present (1 on largest male). Uropodal exopod with 9–10 blunt, movable spines on outer margin of proximal segment of exopod.

*Measurements*: Males (5), TL 12–34 mm; only female examined, TL 18 mm. Odhner (1923) reported a female 26.5 mm long. Other measurements, of male, TL 34 mm, in mm: carapace length 7.4; cornea width 1.7; rostral plate length 2.3, width 2.7; fifth abdominal somite width 6.2; telson length 5.7, width 5.9.

*Remarks*: *Chorisquilla pococki* resembles *C. excavata* in basic facies and it is not too surprising that earlier authors did not recognize it as

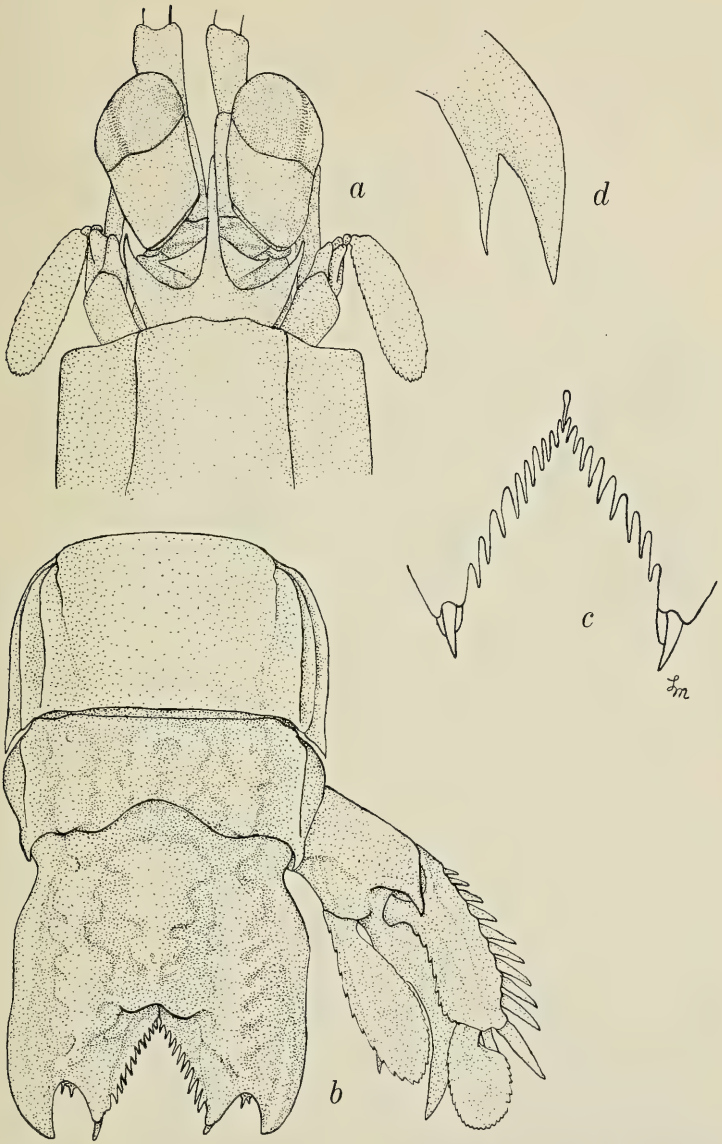



Fig. 2. *Chorisquilla pococki*, new species, ♀ paratype, Macclesfield Bank, South China Sea: *a*, Anterior portion of body; *b*, Posterior 2 abdominal somites, telson, and uropod; *c*, Outline of submedian denticles of telson, ventral view; *d*, Uropod, ventral view. (Setae omitted).

a distinct species. The characters that can be used to separate the two species are listed under the account of *C. excavata.*

Smaller specimens differ from the large male, TL 34 mm, in having more distinct carinae on the submedian and intermediate teeth of the telson (Fig. 1*b*) and in having more (9–10 rather than 7) submedian and intermediate (2 rather than 1) denticles on the telson. The sharp carina of the intermediate teeth merge with the marginal carinae in large specimens, but even in the largest male there is a faint sulcus where the carinae meet.

I have not seen the material reported from the Bonin Islands by Odhner (1923), but inasmuch as he mentions the posterolateral spine on the sixth abdominal somite and refers to Kemp's illustration (in which furrowed dorsal carinae are shown) I believe that his material should be identified with this species rather than with *C. excavata.*

Pocock (1893) recorded one specimen of this species; there are three specimens from Macclesfield Bank in his material which was deposited in the British Museum (Natural History). Hansen (1926) recorded three specimens, from "Siboga" stations 133, 282, and 299. The vial from station 299 was found to include a thalassinid, not a stomatopod. The stomatopod from station 299 may now be lost.

The species is named for R. I. Pocock.

*Distribution*: Hatsune-ure, Bonin Islands (Odhner, 1923); Macclesfield Bank, South China Sea, 26 fms (48 m) (Pocock, 1893); off Ampenan, Lombok, Indonesia, 13 fms (24 m) (Holthuis, 1941); off Lirung, Salibabu Island, Talaud Islands, Indonesia, 36 m (Hansen, 1926); off northeastern Timor, Portuguese Timor, 27–54 m (Hansen, 1926); and off Roti Island, Lesser Sunda Islands, Indonesia, 34 m (Hansen, 1926).

**Chorisquilla andamanica,** new species
Figure 3

*Gonodactylus excavatus.*—Kemp, 1913: 187, pl. 10 figs. 122, 123.—Manning, 1969: 158 (listed).
*Chorisquilla lenzi.*—Manning, 1969: fig. 6 (error in figure legend).
*Chorisquilla excavata.*—Manning, 1969: 159 (key).

*Material*: Off Andaman Islands: 20 fms (37 m); "Investigator"; 2♂, 4♀ (♂, TL 18 mm, is holotype, others are paratypes); IM 9177/6 (1♂, TL 13 mm, paratype, USNM 143562).—Off Little Andaman Island; 10.5 fms (19 m); "Investigator"; paratypes, 1♂, 3♀, TL 16–26 mm; IM 9850-3/6.—Off Table Island, Coco group, Andaman Islands; 9.5 fms (17 m); "Investigator"; paratypes 1♂, 3♀, TL 13–16.5 mm; IM 9846-9/6.

*Diagnosis*: Fifth abdominal somite (Fig. 3*b*) smooth dorsally, with sharp posterolateral angles and 2 longitudinal grooves above margin. Sixth abdominal somite (Fig. 3*b*) with 3 pairs of dorsal bosses, smooth dorsally, none armed, margins of intermediates irregular in outline.

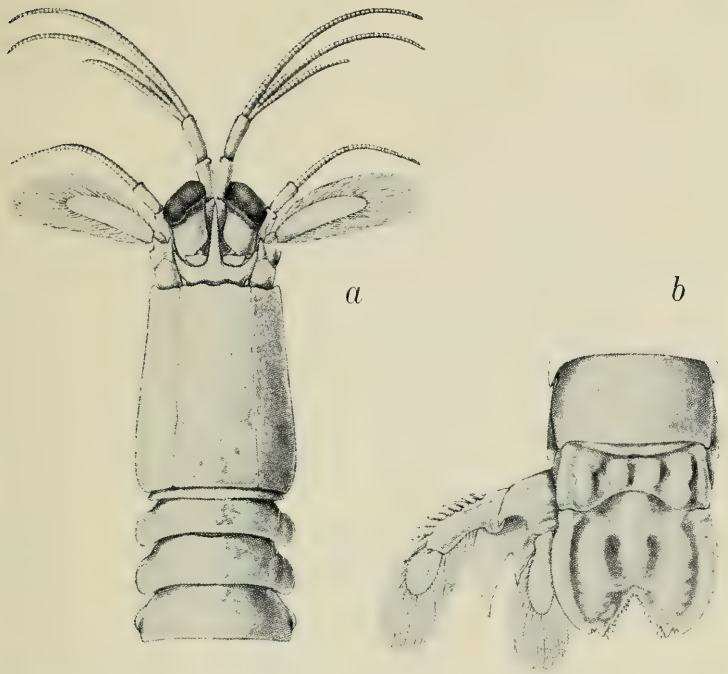



Fig. 3. *Chorisquilla andamanica*, new species (from Kemp, 1913, pl. 10 figs. 122, 123): *a*, Anterior part of body; *b*, Posterior 2 abdominal somites, telson, and uropod.

Telson (Fig. 3*b*) length and width subequal, appearing elongate, with 5 prominent longitudinal bosses, smooth dorsally, on dorsal surface, margins of median and submedians very irregular, eroded; submedians with smaller, separate lobe posteromesially. Median boss (Fig. 3*b*) of telson not extending to anterior margin of median posterior incision, separated from incision by transverse ridge extending from each dorsal submedian carina. Submedian bosses extending almost to bases of submedian teeth. Marginal bosses smooth, rounded dorsally, not furrowed laterally or mesially. Telson with 2 pairs of marginal teeth, separated by shallow incision, submedians extending slightly posterior to intermediates. Submedian tooth smooth dorsally, lacking distinct dorsal carina, apices acute but blunt, with movable, submarginal apical spine. Intermediate tooth, broader than submedian, apices blunt, obtuse. 11–12 slender submedian (Fig. 3*b*) and 2 slender intermediate denticles present. Uropodal expod with 9–11 blunt, movable spines on outer margin of proximal segment.

*Measurements*: Kemp (1913) reported 14 specimens with total lengths ranging from 11.5 to 26 mm. Other measurements of a female, TL 18 mm, in mm: carapace length 2.7; cornea width 0.8; rostral plate length 1.2, width 1.3; antennal scale length 1.1; fifth abdominal somite width 2.1; telson length 2.3, width 2.1.

*Remarks*: *Chorisquilla andamanica* is very similar to both *C. excavata* and *C. pococki*, agreeing with the latter and differing from the former in having laterally eroded and irregular median and dorsal submedian bosses on the telson. It further agrees with *C. pococki* in having a relatively short median boss on the telson which does not extend to the anterior margin of the median incision. It differs from both species in lacking posterolateral spines on the sixth abdominal somite and in having much smaller marginal incisions between the submedian and intermediate marginal teeth.

Kemp's figure of this species is so good that I have decided to reproduce it here (Fig. 3) rather than have a new illustration prepared. It was also reproduced in Manning (1969, Fig. 6) where it was inadvertently labelled *Chorisquilla lenzi*.

The name is derived from the type-locality, the Andaman Islands.

*Distribution*: Known only from the Andaman Islands, in depths between 9.5 and 20 fms (17 and 37 m).

## Literature Cited

Brooks, W. K. 1886. Report on the Stomatopoda collected by H.M.S. "Challenger" during the years 1873–1876. Rep. Voy. Challenger, Zool. 16:1–116, pls. 1–16.

Dawydoff, C. 1952. Contribution a l'étude des invertébrés de la faune marine benthique de l'Indochine. Bull. Biol. France Belgique, supp. 37:1–158, maps 1–2.

Gravier, C. 1937. Stomatopodes des côtes d'Indo-Chine. Ann. Inst. Océanogr. Monaco 17(3):175–211, figs. 1–23.

Hansen, H. J. 1926. The Stomatopoda of the Siboga Expedition. Siboga Exped., Monogr. 35:1–48, pls. 1–2.

Holthuis, L. B. 1941. The Stomatopoda of the Snellius Expedition. Biological results of the "Snellius" Expedition, no. 12. Temminckia 6:241–294, figs. 1–9.

Kemp, S. 1913. An account of the Crustacea Stomatopoda of the Indo-Pacific region, based on the collection in the Indian Museum. Mem. Indian Mus. 4:1–217, 10 text-figs., pls. 1–10.

Manning, Raymond B. 1969. Notes on the *Gonodactylus* section of the Gonodactylidae (Crustacea, Stomatopoda), with descriptions of four new genera and a new species. Proc. Biol. Soc. Washington 82:143–166, figs. 1–8.

Miers, E. J. 1880. On the Squillidae. Ann. Mag. Nat. Hist. (5) 5:1–30, 108–127, pls. 1–3.

Odhner, T. 1923. Indopazifische Stomatopoden. Göteborg Vetensk. Samh. Handl. (4) 27(4):1–16, figs. 1–10.

Pocock, R. I. 1893. Report upon the stomatopod crustaceans obtained by P. W. Basset-Smith, Esq., Surgeon R.N., during the cruise, in the Australian and China Seas, of H.M.S. "Penguin," Commander W. U. Moore. Ann. Mag. Nat. Hist. (6):11:473–479, pl. 20B.

Serène, R. 1939. Note sur les stomatopodes des eaux indochinoises. Bull. Soc. Zool. France, Paris 64:343–349, figs. 1–4.

———. 1953. Sur la collection des stomatopodes de l'Institut Océanographique de l'Indochine. Proc. 7th Pacific Sci. Congr., 1949, 4, Zool. p. 506–508.

———. 1954. Observations biologiques sur les stomatopodes. Mém. Inst. Océanogr. Nhatrang 8:1–91, text-figs. 1–15, pls. 1–10.

QH
1
B4X
NH

No. 25, pp. 263–280 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES
AUG 21 1975

# NOTES ON INDO-PACIFIC PIPEFISHES (PISCES: SYNGNATHIDAE) WITH DESCRIPTION OF TWO NEW SPECIES

By C. E. Dawson and J. E. Randall
*Gulf Coast Research Laboratory Museum, Ocean Springs, Mississippi 39564, and Bernice P. Bishop Museum, P. O. Box 6037, Honolulu, Hawaii 96818*

Among Indo-Pacific pipefishes recently received for study are two undescribed species and several specimens that provide important additions to our knowledge of five poorly known species. The new species are described here and descriptive notes and comment are included for other material. Measurements are in millimeters (mm); body proportions are referred to standard length (SL) or head length (HL); unless otherwise stated, coloration is described from specimens preserved in alcohol; depths are reported in meters (m), distances in kilometers (km). Study materials are deposited in collections of the Academy of Natural Sciences of Philadelphia (ANSP), Bernice P. Bishop Museum (BPBM), California Academy of Sciences (CAS), Gulf Coast Research Laboratory Museum (GCRL), Museo Storia Natural, Genoa (MSNG), Rijksmuseum van Natuurlijke Historie (RMNH), University of Guam (UG) and National Museum of Natural History, Smithsonian Institution (USNM).

Appreciation is expressed to S. S. Amesbury (UG), M. Boeseman (RMNH), J. E. Böhlke and W. F. Smith-Vaniz (ANSP), B. A. Carlson (Univ. S. Pacific, Fiji), W E. Eschmeyer and Pearl Sonoda (CAS), L. W. Knapp (Smithsonian Oceanographic Sorting Center), M. McCoy, E. Tortonese (MSNG) and V. G. Springer (USNM) for making materials available for study. The holotype of *Micrognathus boothae*

FIG. 1. Delineation of head of *Micrognathus boothae* USNM 213481.

was reexamined by J. R. Paxton, Australian Museum. Data on the holotype of *Halicampus macrorhynchus* were provided by A. C. Wheeler (BMNH), British Museum (Natural History). Dr. Springer's Indonesian material was collected during Rumphius Expedition I of the Indonesian Institute of Oceanology. Seychelles and Amirantes collections were by J. E. Böhlke and associates during The International Indian Ocean Expedition–Seychelles Island Program 1964 (IIOE). Specimens of *Corythoichthys amplexus* from the Solomon Islands collected by the junior author and G. R. Allen were obtained during an expedition supported by the National Geographic Society. Drawings are by Anne Langenfeld (GCRL). This study was in part supported by National Science Foundation Grant GB-31053X to the senior author.

*Micrognathus boothae* Whitley
Figure 1

*Material examined*: USNM 213481 (1, 130 mm SL); Fiji Is., Wailangilala Is., 16°45′S, 179°02′E, coral reef, 0.3–6.4 m, TE VEGA Cr. 7, Sta. 295, 26 May 1965.

*Counts and measurements*: Dorsal fin rays 20; caudal rays 10; pectoral rays 10–11; anal rays 4; rings 14 + 41; subdorsal rings 0.5 + 4 = 4.5; brood pouch occupies anterior 13 tail rings, contains eggs over 11 rings. Head length 7.8 mm (16.1 in SL); snout length 2.3 (3.4 in HL); eye diameter 1.7 (4.6 in HL); dorsal fin base 10.0 (0.8 in HL); caudal fin length 2.9.

*Descriptive notes*: Median frontal and nuchal ridges slightly developed, prenuchal ridge obsolete. A rudimentary opercular ridge crosses anterior ¼ of opercle; distinct ridges absent from pectoral cover plate but both opercle and cover plate crossed by striae so as to impart a pocked or waffle-like surface configuration. Lateral tail ridge terminates below dorsal fin origin; scutellar width about equals ⅓ distance between

proximal margins of adjacent scutella. Brood pouch contains single layer of eggs arranged in four transverse rows, with outermost row containing 29–30 eggs. Pouch folds voluminous, will meet on ventral midline but margins not thickened and there is nothing to indicate that folds overlap in life. Ground color dark brown, venter and distal ⅔ of brood pouch folds lighter. Snout tip tan; with indications of widely spaced narrow pale bars crossing dorsum: three on trunk, five behind dorsal fin. Pectoral and anal fins pale; dorsal fin with narrow shading of melanophores proximad, elsewhere pale.

*Discussion*: Whitley (1964) described *M. boothae* from a single specimen (presumably female) from Lord Howe Island. Meristic data were given as: D 21, A 2, P 11, C 7, rings 14 + 42 and subdorsal 1 + 5. Dr. J. R. Paxton has reexamined this fish at our request and finds 22 dorsal, 10 caudal and 4 anal rays. Whitley (p. 163) described the dorsal fin base as "extending over almost six tail-rings" and it appears that relative dorsal fin lengths and positions are very similar in these specimens.

The Fiji specimen represents the second known specimen, and only known male, of *M. boothae*, and extends the species range more than 2200 km to the northeast of the type-locality. A month of intensive collecting of fishes at Lord Howe Island in 1973 by Randall and nine other ichthyologists resulted in 278 species of fishes (189 were new records), but failed to produce additional specimens of *M. boothae*.

### *Micrognathus brocki* Herald

*Material examined*: Indonesia: USNM 209722 (1, 64 mm SL), Tandjung Suli, 11 Jan. 1973. Mariana Is.: UG 5776 (+ 58, tail damaged), Guam, 22.9 m, 27 Dec. 1971.

*Counts and measurements*: (USNM 209722): Dorsal fin rays 21; pectoral rays 12-11; caudal rays 10; anal rays 4; rings 14 + 35; subdorsal rings 0.5 + 4.5 = 5.0. Head length 6.1 mm (10.5 in SL); snout length 2.2 (2.8 in HL); eye diameter 1.3 (4.7 in HL); dorsal fin base 5.6 (1.1 in HL); caudal fin length 2.1.

*Descriptive notes*: Median snout ridge tripartite (see Herald 1953: 259, fig. 39g); 5 spinules on anterior, 4 on middle and 2 on posterior segments (8, 3 and 2 in Guam specimen). Supraorbital cirri branched, right cirrus about 2.4 mm in length, left somewhat shorter; suborbital cirri shorter than eye diameter, distally branched; eye with about 12, equally spaced, fleshy flaps or cirri; cirrus on frontal crest about 3.5 mm long, profusely branched proximad but distal half simple; prenuchal crest with short, broad, leaflike cirrus; single branched cirrus near middle of each opercle. Most trunk rings bear minute cirri near dorsal and ventral margins; 4th, 8th, 12th and 16th rings with expanded, leaflike cirri on each lateral and dorsal ridge (4 per ring). Ground color white; lower half of opercle brownish; two brown bands pass ventrad between lateral midlines of snout; dorsum and sides of body crossed by about 9

indistinct brownish bands (3–4 rings wide) each alternating with 1–2 pale rings; venter with brownish shading on pectoral ring followed by narrow brown bars between each of next 12–13 rings.

*Discussion*: *Microgнathus brocki* was described from a 110 mm SL female (?) taken at Bikini Atoll, Marshall Islands. A second specimen (82 mm SL) was subsequently reported from the Ryukyu Islands (Herald and Randall, 1972), but egg bearing males are yet to be recognized. The present Indonesian juvenile extends the known range more than 5500 km west southwest of the type-locality and suggests widespread distribution in central Pacific waters.

*Microgнathus edmonsoni* (Pietschmann)

*Material examined*: ANSP 128417 (1, 62 mm SL); Fiji Is., Viti Levu, E side Mbengga Is., ca. 37 km SW of Suva harbor, 24.4 m, 14 Apr. 1974.

*Counts and Measurements*: Dorsal fin rays 19; caudal rays 10; pectoral rays 12; anal rays 4; rings 14 + 38; subdorsal rings 0.25 + 3.75 = 4.00 Head length 5.4 mm (11.5 in SL); snout length 2.3 (2.4 in HL); eye diameter 1.1 (4.9 in HL); dorsal fin base 4.4 (1.2 in HL); caudal fin length 2.4.

*Descriptive notes*: Median snout ridge low, entire, more or less bipartite, the shorter anterior portion slightly notched behind; opercular ridge indistinct, extends across ⅔ of opercle; remaining head ridges low, with entire margins; one ridge on pectoral cover plate. Superior trunk and tail ridges prominent, margins minutely serrate over all but last 10–12 tail rings; other trunk and tail ridges entire. Ground color pale; sides with traces of about 13 widely spaced brownish blotches; ventral part of head lightly shaded with brown; venter elsewhere with brown shading on 1st and 2nd trunk rings and indications of narrow brown bars between remaining trunk rings.

*Discussion*: Compared with a 65 mm SL fish from the Marquesas Is. (CAS 13977), the present specimen has more prominent superior trunk and tail ridges with somewhat more pronounced serrations; pectoral fin rays are 12 in both. Herald (1953) reported *M. edmonsoni* to have rounded body ridges without serrations and 10 pectoral rays. Our observations show pectoral rays to range from 10 to 12 and that superior trunk and tail ridges are serrate in juveniles. Originally described from Hawaii, *Microgнathus edmonsoni* was recently reported from the Marquesas Is. (Herald and Randall, 1972). The present record extends the known range some 5144 km southwest of the type-locality.

*Syngnathus banneri* Herald and Randall
Figures 2 and 3

*Material examined*: Amirante Isles: ANSP 128817 (1, 36 mm SL), Remire Reef, NE of Eagle Is., ca. 9.1 m, 4 Mar. 1964, IIOE Sta. F-82; ANSP 128818 (1, 43), off E side D'Arros Is., 15.2–27.4 m, 5 Mar.

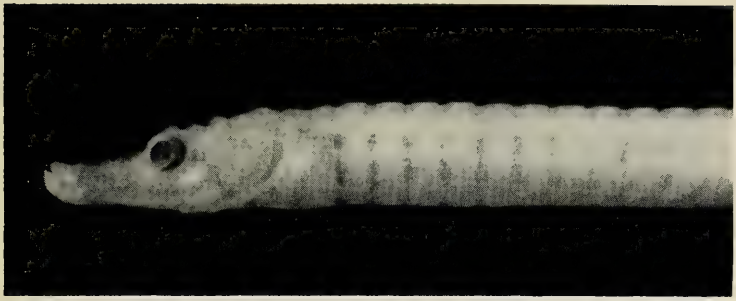


FIG. 2. Head and anterior body of *Syngnathus banneri* GCRL 13350; 52 mm SL male.

1964, IIOE Sta. F-87. Seychelles: ANSP 128819 (1, 58), GCRL 13350 (1, 52), off S shore of Faon Is., 10.7–13.7 m, 22 Jan. 1964, IIOE Sta. F-11; ANSP 128816 (1, 52), vicinity of Praslin Is., S of Round Is., 12.2–15.2 m, 22 Feb. 1964, IIOE Sta. F-61. Mauritius: BPBM 16343 (2, 41–46), W coast, cave in 30 m, 20 Nov. 1972. Indonesia: USNM 213482 (1, 35), Saparua, S of Kampungmahu, 9.1 m, 18 Jan. 1973. Taiwan: USNM 213810 (1, 44), SW shore off Ch'uan-fan-shih, 21°55'48"N, 120°48'48"E, 7.6–8.5 m, 2 May 1968.

*Counts and measurements*: Dorsal fin rays 17–20; pectoral rays 12–14; anal rays 3–4 (usually 4); caudal rays 10; trunk rings 15; tail rings 27–29; subdorsal rings 0.5–1 + 3.25 = 4–4.75; head in SL 7.1–8.2; snout in HL 2.2–2.5; dorsal fin base in HL 1.4–1.7. Male brood pouch on anterior 11–14 tail rings.

*Descriptive notes*: Median snout ridge (Fig. 3) well developed, begins at rear of upper jaw, deeply incised to form 3 or 4 distinct, semi-isolated, subtriangular sections; broadly truncate lateral projection located below level of nares and near middle of snout length; most specimens with small lateral spine just behind angle of gape. Orbital ridge expanded dorsad to form a broadly rounded or truncate dorsolateral projection; postorbital ridge with a rather broad lateral projection just behind eye; median frontal, prenuchal and nuchal ridges elevated; supraorbital ridge represented by a short knob-like projection; opercular ridge crosses about ⅓–½ of opercle; remaining opercular surface pocked between radiating striae; upper and lower pectoral cover plate ridges distinct in most specimens. Lateral trunk and tail ridges overlap on anal ring in one specimen, fail to overlap in other material; superior and inferior trunk and tail ridges somewhat elevated, well indented between rings of trunk and anterior ⅓ of tail, distinctly notched between remaining tail rings; body surfaces concave between ridges; head and body ridges rough to minutely serrate in all specimens. Scutella rather broad, greatest width about ½ distance between proximal margins of

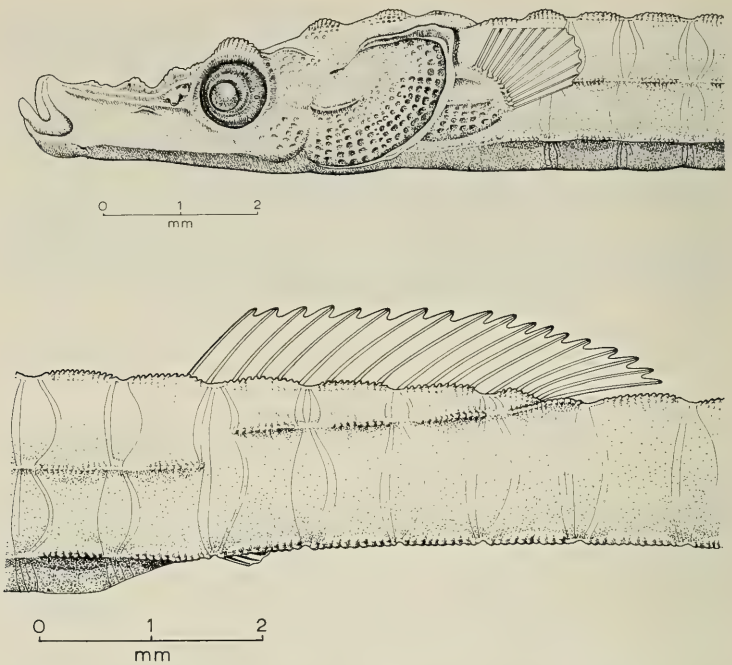



Fig. 3. *Syngnathus banneri.* Top: lateral aspect of head and anterior trunk rings. Bottom: Section of body illustrating ridges, dorsal and anal fins. Drawn from 43 mm SL female, ANSP 128818.

adjacent scutella; neuromasts indistinct but apparently present on tail rings. Eye with ring of 10–12, equally spaced, minute flaps; cirri otherwise absent.

Brood pouch folds of egg bearing males do not meet on ventral midline, and margins appear to be neither thickened nor otherwise modified. A 46 mm SL fish (BPBM 16343) has the pouch extending over 12 rings and about 29 eggs in two longitudinal rows. A 52 mm specimen (GCRL 13350) has two (occasionally three) transverse rows of eggs over 11 rings, about 17 in outer row and 41 in pouch.

Most specimens are mainly pale; well marked individuals have faint indications of a narrow bar from posteroventral margin of eye across anterior portion of opercle; dorsum crossed by faint dark blotches (bars) on about every 4th ring behind pectoral ring; ventral portion of pectoral ring crossed by dusky bar; sides below lateral trunk ridges and venter crossed by indications of narrow bars on trunk rings 2 through 10; body and head without other markings; fins pale. In some specimens, bars on lower sides and venter interrupted, forming a series of vertically-

oriented, oblong spots on each lateral trunk ridge, each inferior trunk ridge and on ventral ridge. One 41 mm SL fish (BPBM 16343) is mainly brownish, the dorsum crossed by 9–10 broad bars (bars to about 5 rings in length) separated by mottled pale areas (0.5–1 ring in length) and lower sides and venter ringed by narrow brown bars on each trunk ring.

*Discussion*: Herald and Randall (1972) described *S. banneri* from two specimens (26.5–39 mm SL) from the Ryukyu and Marshall Islands. Reexamination shows 4 anal rays in each (rather than 2 as described) and 12 rather than 11 rays in the left pectoral fin of the paratype. Although omitted from the original description and figure, the 39 mm holotype bears a minute lateral spine behind angle of gape and a larger lateral projection near middle of snout length; both processes are reduced but definitely present in the paratype. The condition of the holotype precludes observation of eye flaps, but some are present on the paratype.

Pectoral rays are modally 13 in our material but meristic and morphometric characters fall within expected variation of *banneri*. Among Indian Ocean specimens, larger fish have shorter opercular ridges and greatest development of other head and body ridges. Herald and Randall speculated that *banneri* would have an overlapping brood pouch closure and thereby fall within the subgenus *Microsyngnathus* Herald. Out material shows that *Syngnathus banneri* has the "semi-brood-pouch closure" of Herald (1959) wherein eggs are arranged in one layer and margins of pouch folds do not meet on ventral midline. Pouch closure and egg arrangement suggest that *banneri* is intermediate between two of the four nominal subgenera of *Syngnathus*: *Microsyngnathus* (overlapping pouch folds, anal fin present) and *Bryx* Herald (non-overlapping folds, anal fin absent).

Our specimens extend the known distribution to Indonesia and the western Indian Ocean. All specimens, including type material, have been taken in coral habitats within the 6.1–30 m depth range.

**Syngnathus darrosanus,** new species
Figures 4 and 5

*Holotype*: ANSP 128815 (47.4 mm SL); Amirante Isles, off E side of D'Arros Island (Admiralty Chart No. 724), 0–2.1 m, 6 Mar. 1964, IIOE Sta. F-91.

*Paratype*: GCRL 13302 (43.3 mm SL), collected with holotype.

*Diagnosis*: Dorsal fin rays 23; pectoral rays 12; anal rays 3; caudal rays 10 (in holotype); trunk rings 16; tail rings 29–30; subdorsal rings 6.25 (2 trunk + 4.25 tail rings); head in SL 7.9; snout in HL 2.8–2.9; dorsal fin base in HL 1.1. Body ridges indented between rings; all ridges smooth, neither serrate nor spinulose. Ridge pattern typical of *Syngnathus*, i.e., lateral trunk ridge discontinuous with lateral tail ridge near anal ring, inferior trunk and tail ridges continuous and superior

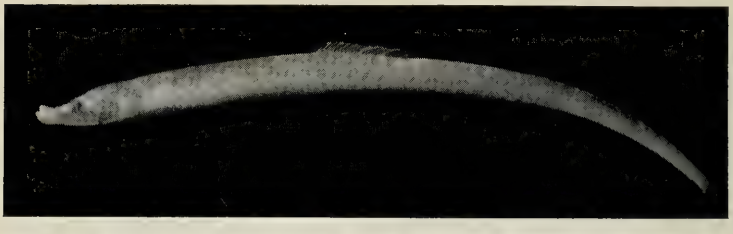


FIG. 4. *Syngnathus darrosanus* ANSP 128815; holotype; 47 mm SL.

trunk and tail ridges discontinuous near rear of dorsal fin. Trunk V-shaped ventrad; brood pouch unknown.

*Description*: Measurements (mm) are as follows: head length 6.0 (5.5 in paratype); snout length 2.1 (2.0); eye diameter 1.1 (1.0); length of dorsal fin base 5.5 (5.2); pectoral fin length 1.2 (1.1); length of pectoral fin base 0.9 (0.8); caudal fin length 1.1 (damaged in paratype).

Median snout ridge (Fig. 5) smooth, begins near middle of snout length with two well separated, subtriangular, dorsal expansions, not deeply incised; snout without lateral spines; orbital ridge low, not expanded dorsolaterad; median frontal, prenuchal and nuchal ridges low, indistinct. Opercular ridge extends over ⅓ to ½ of opercle, opercle elsewhere crossed by radiating striae imparting a waffle-like surface configuration; upper and lower pectoral cover plate ridges present. Trunk and anterior ⅓ of tail with slightly elevated, rounded ridges, only slightly indented between rings. Ridges on remainder of tail deeply incised between rings, margins elevated, tail surface concave between; head and body ridges entire. Lateral trunk and tail ridges overlap on 2nd tail ring in holotype; lateral trunk ridge ends on 1st tail ring in paratype and falls short of lateral tail ridge, which ends near middle of 2nd tail ring. Eye bears circle of 17–18 minute, equally-spaced, pale flaps or cirri; head and body elsewhere devoid of cirri; scutella oval, rather broad, width about ½ distance between proximal margins of adjacent scutella; neuromasts in short series on posterior half of each tail ring.

Predominantly brown with faint mottling of tan; upper half of snout and tip of lower jaw pale; dorsum of trunk and tail with indications of several pale bars of irregular width and spacing; dorsal and pectoral rays streaked with brown, membranes mainly pale; caudal fin dark brown with narrow pale margin.

*Etymology*: Named *darrosanus*, in reference to the type-locality, D'Arros Island.

*Discussion*: Both specimens are assumed to be adult or subadult females and future collections of egg bearing males will probably show this species to be a member of the poorly defined *Bryx-Microsyngnathus* group of subgenera. *Syngnathus darrosanus* seems most closely related

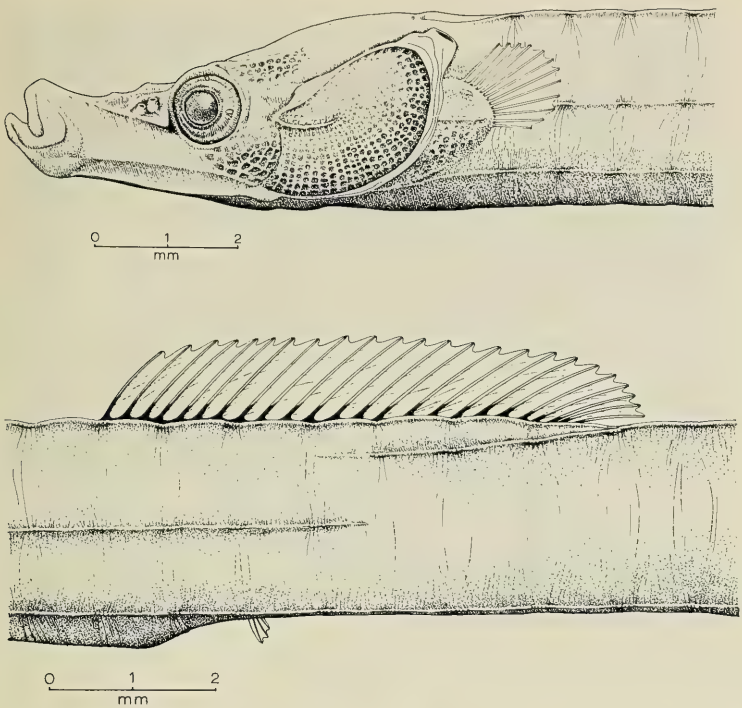



FIG. 5. *Syngnathus darrosanus.* Top: Lateral aspect of head and anterior trunk rings. Bottom: Section of body illustrating ridges, dorsal and anal fins. Drawn from holotype.

to such small forms as S. *balli* (Fowler) and S. *banneri* Herald and Randall. The combination of 16 trunk rings, 29–30 tail rings, 23 dorsal fin rays, smooth ridges, and short snout clearly separates S. *darrosanus* from congeners.

**Corythoichthys amplexus,** new species
Figures 6 and 7

*Holotype*: USNM 213479 (66 mm SL, male), Fiji Islands, Beqa Lagoon, patch reef between Stuart and Yanuca Islands, 6.1 m, rotenone, 16 Jan. 1974, B. Carlson and B. Goldman.

*Paratypes*: Fiji Is.: BPBM 17949 (2, 44–54), GCRL 13337 (5, 44–62), USNM 213480 (2, 45–54), taken with holotype. Solomon Is.: BPBM 15614 (2, 59–71), GCRL 13336 (1, 68), Alite Reef off Malaita, lagoon coral head, 3 m, 24 July 1974, J. E. Randall and G. R. Allen. Celebes Is.: USNM 213510 (8, 49–69), GCRL 13358 (2, 54–64), Kabena Is.,

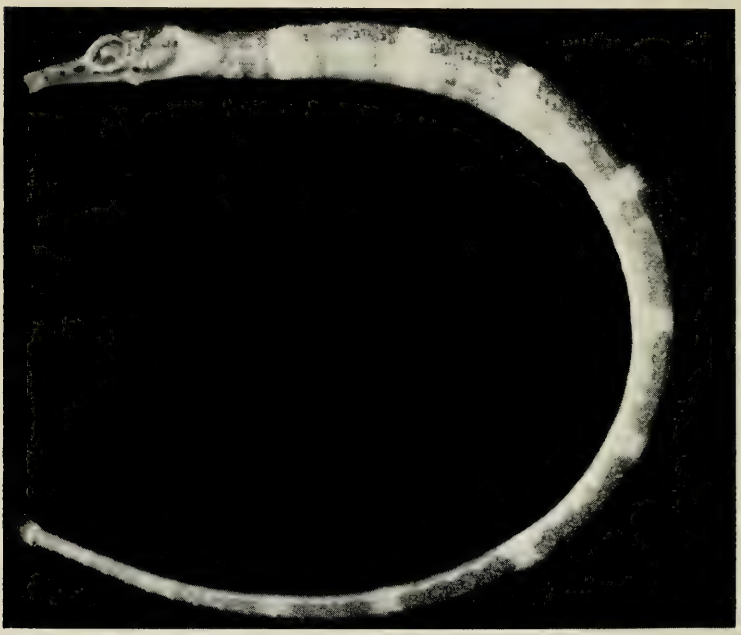


Fig. 6. *Corythoichthys amplexus* GCRL 13336; paratype; 68 mm SL.

Tallabassi Bay, off NE tip of Big Damalawa Is., ca. 05°17′20″S, 122°04′00″E, 2–15 m, 25 Feb. 1974, V. G. Springer. New Guinea: USNM 213511 (1, 66), Madang harbor, inside S tip of Paeowai Is., 9.1–10.7 m, 26 May 1970, B. B. Collette. Seychelles: ANSP 110058 (8, 55–70), Mahé Is., NW end Beau Vallon Bay, isolated coral outcrop in sand, 6.1–7.5 m, 15 Mar. 1964, IIOE Sta. F-114; ANSP 110017 (1, 59), Beau Vallon Bay, NNW of Hotel des Seychelles, 12.2–15.2 m, 19 Mar. 1964, IIOE Sta. F-119; ANSP 108993 (1, 68), Mahé Is., W side of N islet, 7.6–18.3 m, 16 Mar. 1964, IIOE Sta. F-115; ANSP 110053 (5, 68–88), vicinity Praslin Is., S of Round Is., to 15.2 m, 22 Feb. 1964, IIOE Sta. F-61; ANSP 108972 (63, 50–89), BPBM 18033 (4, 65–70), GCRL 13463 (6, 70–88), Curieuse Is., S end Laraie Bay, to 9.1 m, 23 Feb. 1964, IIOE Sta. F-64. Amirante Isles: ANSP 110050 (5, 49–64), off E end D'Arros Is., 21.3–30.5 m, 6 Mar. 1964, IIOE Sta. F-89; ANSP 110036 (4, 55–76), African Is., SW of North Is., to 3.7 m, 3 Mar. 1964, IIOE Sta. F-80.

*Other material*: GCRL 13338 (2, with regenerated tails), taken with holotype. ANSP 110052 (1, anomalous), Seychelles, off N tip of Mahé Is., ca. 18.3 m, 14 Feb. 1964, IIOE Sta. F-50.

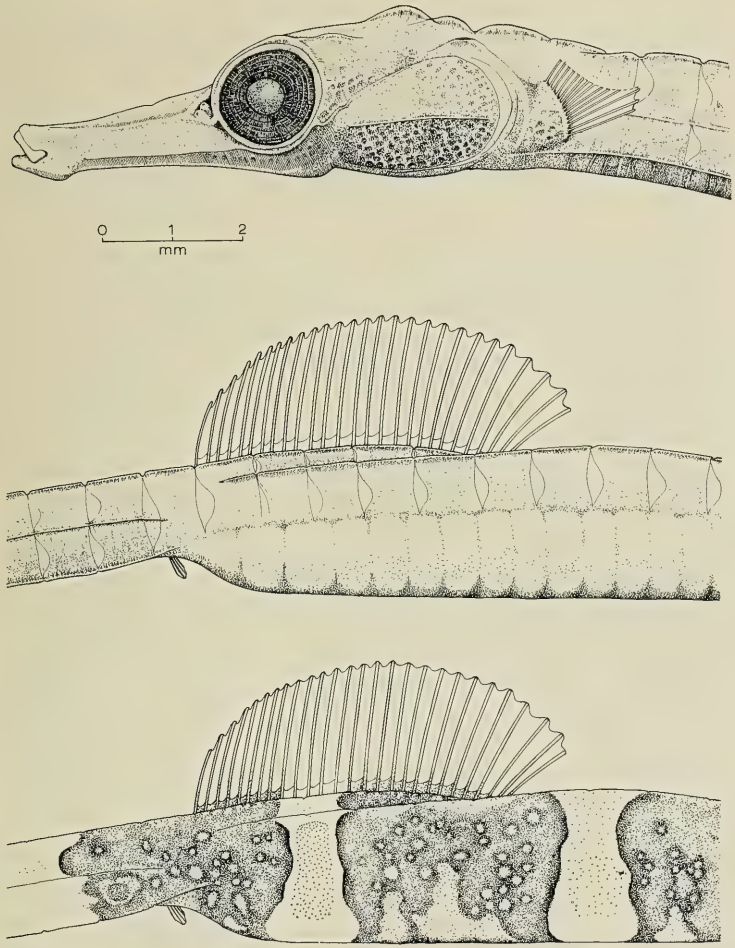



Fig. 7. *Corythoichthys amplexus*. Top: Lateral aspect of head and anterior trunk rings. Middle: Section of body illustrating ridges, dorsal and anal fins and portion of brood pouch. Bottom: Same section showing color pattern. Drawn from holotype.

*Diagnosis*: Dorsal fin rays 24–29 (modally 26); pectoral fin rays 12–15 (14); caudal rays 10; anal rays 4; trunk rings 15–16 (15); tail rings 35–39 (37); subdorsal rings 4.5–6.25 (average 5.2); dorsal fin origin on 1st or 2nd tail ring; snout short, averages 2.5 in head length. Ridge pattern typical of *Corythoichthys*, i.e., lateral trunk ridge discon-

tinuous with lateral tail ridge near anal ring, inferior trunk and tail ridges continuous, superior trunk and tail ridges discontinuous near rear of dorsal fin. Trunk slightly V-shaped ventrad; brood pouch of males without protective plates, located on anterior 11–13.5 tail rings. Body ringed by 11–13 (usually 12) broad brown bands behind head, 4 bands from pectoral ring to 2nd–4th tail ring, 7–9 on remainder of tail; sides of head without wavy lines or stripes; no dark blotch near anus.

*Description*: Counts and measurements (mm) of holotype: Dorsal fin rays 27; pectoral rays 14(2); caudal rays 10; anal rays 4; rings 15 + 38; subdorsal rings 5.5 from anterior edge of 2nd tail ring; brood pouch on 13 rings. Head length 6.9; snout length 2.8; eye diameter 1.7; length of pectoral fin base 0.9; caudal fin length 2.5. Range and means (in parentheses) of principal proportions for holotype and paratypes: head length in SL 7.9–12.0 (9.5); snout length in HL 2.2–2.8 (2.5); dorsal fin base in HL 1.0–1.4 (1.1). Trunk rings 16 in one fish, 15 in remainder of 124 examined.

Median snout ridge, frontal, prenuchal and nuchal ridges smooth and moderately elevated in holotype (Fig. 7); opercular ridge almost reaches posterior margin of opercle; pectoral cover plate and opercle pocked between radiating striae; trunk ridges distinct, superior ridges mainly entire, somewhat elevated with dorsum concave between, distinct notch between rings; superior tail ridges lower, indented between rings; brood pouch folds broad, their depth at 8th tail ring about ½ greater than remaining depth of tail; pouch with single layer of eggs in 4 transverse rows over 12 rings; egg diameter about 0.6 mm, 65 eggs in pouch.

Ground color light tan, markings brown. Side of snout with dark blotch behind angle of gape, another close to eye; top and sides of head from interorbital to rear of frontal crest and between upper, anterior part of opercles capped with brown; two narrow, dark blotches near ventral margin of opercle, another on gill membranes below; head elsewhere immaculate or peppered with dark chromatophores. Body circled by 4 brown bands from pectoral ring to middle or end of 3rd tail ring, pale interspaces about one ring wide dorsad, somewhat wider below; 7 bands on remainder of tail, last 3 with pigmentation faint and largely restricted to localized concentrations of dark chromatophores in irregular circlets; color bands continue to margins of brood pouch folds but supramarginal pale areas included within 2nd and 3rd color bands crossing brood pouch (Fig. 7). Pectoral rays with scattering of basal chromatophores, the fin otherwise pale; dorsal rays above color bands lined proximad with chromatophores, remainder of fin pale; caudal fin pale, with a single narrow dark bar near base.

Dorsal fin origin between anterior margins of 1st and 2nd tail rings, most frequently near middle of 1st ring. Scutella rather broad, maximum width more than half distance between proximal margins of adjacent scutella. Head crests and body ridges most prominent in Solomons,

Celebes and western Pacific material; superior trunk ridges minutely denticulate in most specimens examined; median snout ridge usually with slight dorsal emargination (Fig. 7).

Details of coloration vary but basic broadly banded pattern is constant; snout lightly shaded with chromatophores in some fish, 1–2 lateral rows of up to 6 small brown spots in others; body bands usually less distinct across venter. Males usually have 2–4 moderately large, dark brown blotches on venter of 1st–3rd trunk rings, whereas females most frequently have several small, tan spots arranged in 2, more or less parallel, longitudinal rows. A color transparency of a fresh Solomon Islands specimen shows pale areas as bluish-white, the markings reddish-brown; dark bands are sprinkled with white and all bands are distinct rather than faded caudad as in most preserved material.

A small species, which probably seldom exceeds 100 mm SL; among our material, the smallest male with brood pouch eggs is 55 mm SL.

*Etymology*: *amplexus*, encircling, in reference to the broad encircling color bands; here used as a noun in apposition.

*Discussion*: Herald (1953) recognized five species and two subspecies within Indo-Pacific populations of *Corythoichthys*. Subsequently, Smith (1963) showed *C. intestinalis* Ramsay to be a junior synonym of *C. haematopterus* (Bleeker), and both Smith (1963) and Klausewitz (1972) questioned the validity of Herald's subspecies: *C. intestinalis intestinalis* (E. Africa to New Hebrides) and *C. intestinalis waitei* (Jordan and Seale) from New Hebrides, Fiji and other central Pacific localities. With the exception of *C. ocellatus* Herald, a long-snouted form with 30–31 tail rings described from the Solomon Islands, all nominal species exhibit considerable overlap in meristics and identification is largely based on differences in proportional characters and coloration. *Corythoichthys amplexus* is readily distinguished from all congeners by the combination of short snout, modally 15 trunk rings and broadly banded color pattern. Trunk rings are modally 16–18 in other Pacific species and counts of 15 have occurred in only 20 of 570 specimens examined (Herald, 1953 and our unpublished data). Frequency of trunk rings is one of the most stable meristic features of pipefishes and the modal count of 15 in *amplexus* is distinctive. The number of pectoral fin rays (13 or 14 in 92% of 235 counts) also differs from that of Pacific congeners wherein modal values are 15 or 16 (detailed meristic comparisons will be provided in a review of the genus now in preparation by Dawson). Other short-snouted species, *C. flavofasciatus* Rüppell and *C. haematopterus*, also have banded coloration but this is rather poorly defined; the bands and pale interspaces are often about equal in length and there are either distinctive stripes or wavy lines on the head (absent in *amplexus*). In addition, males of *flavofasciatus* have a dark, perianal blotch and males (and some females) of *haematopterus* usually have prominent, dark bars crossing venter of the anterior 3–5 trunk rings. Available

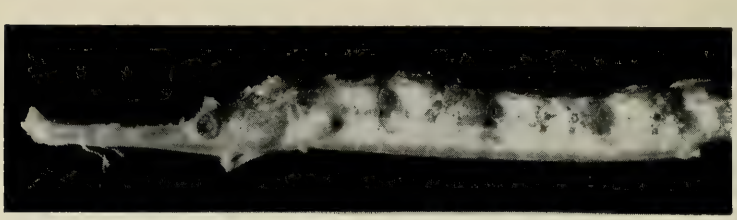


FIG. 8. Head and anterior body of *Halicampus macrorhynchus* BPBM 17354; 149 mm SL.

data suggest that *C. amplexus* prefers protected coral habitats within the 2–31 m depth range.

*Halicampus macrorhynchus* Bamber
Figures 8 and 9

*Material examined*: BPBM 17354 (1, 149 mm SL), Solomon Is., Guadalcanal, Point Cruz, Honiara, among "algae" covered rocks, 25 m, Jan. 1974.

*Counts and measurements*: Dorsal fin rays 18; pectoral fin rays 19–18; caudal rays 10; anal rays 4; rings 14 + 25; subdorsal rings 2.75 (1.5 trunk + 1.25 tail rings). Head length 30.0 mm (5.0 in SL); snout length 18.5 (1.6 in HL); eye diameter 3.0; length of dorsal fin base 7.6 (4.0 in HL); pectoral fin length 2.5; length of pectoral base 3.6; caudal fin length 6.1.

*Description*: Median snout ridge (Fig. 9) low, represented mainly by a series of distinct spines and short elevated ridges; additional spines laterad on snout; orbital ridge spiny anteriad, expanded above eye to form a large subtruncate, dorsolateral projection; suborbital ridge produced into a large, somewhat spiny, knoblike, lateral protrusion; opercular ridge anteriorly expanded to form a flat, medially-notched, lateral projection, ridge low behind, directed dorsad, crossing entire opercle; supraopercular ridge low in front, expanded into a broad, flat projection behind; pectoral cover plate with broad, distally curved, shelflike projection near lower pectoral angle and a small, flat, spinelike projection just before upper angle of fin; a strong ridge runs ventrad from anterior edge of cover plate, terminating in a substantial, recurved, hooklike knob at anterolateral margin of pectoral ring. Median frontal ridge rather low and denticulate in front, higher behind; prenuchal and nuchal ridges lower, more or less subconical; interorbital deep between supraorbital ridges.

All body ridges distinct, their margins granular, clearly notched or indented between rings; dorsum and sides concave between ridges; trunk V-shaped ventrad. Inferior trunk and tail ridges discontinuous; lateral trunk ridge continuous with inferior tail ridge; superior trunk and tail ridges discontinuous below dorsal fin. Lateral trunk ridge produced

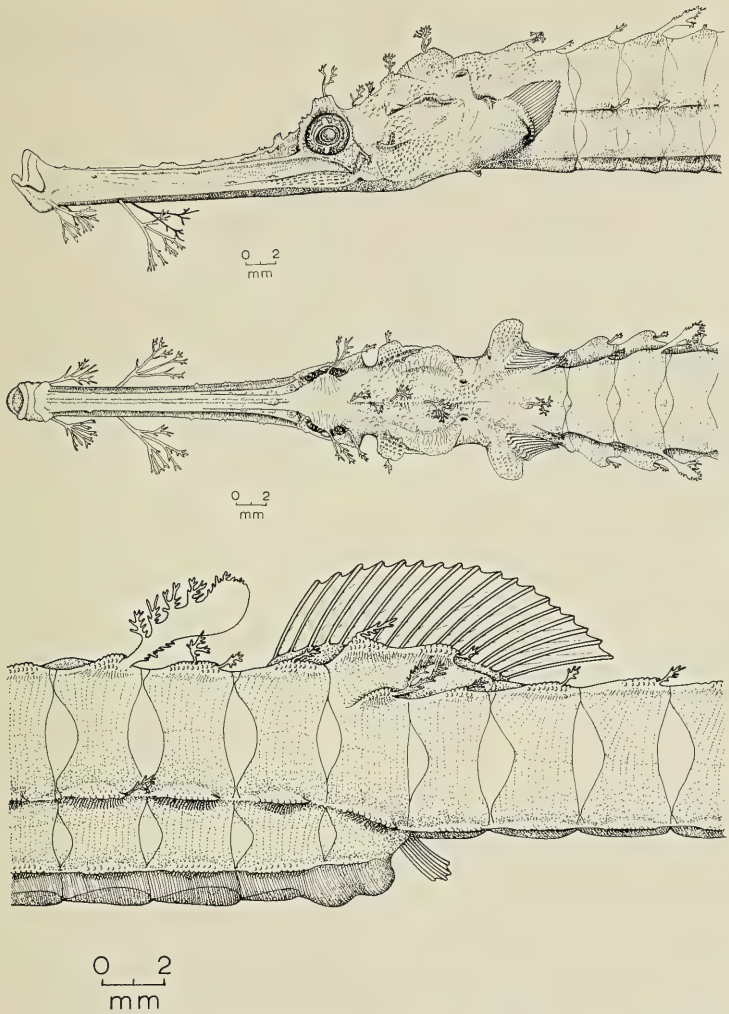



FIG. 9. *Halicampus macrorhynchus* BPBM 17354. Top and middle: Lateral and dorsal aspect of head and anterior trunk rings. Bottom: Section of body illustrating ridges, cirri, dorsal and anal fins.

on each ring to form strong, recurved, hooklike projection. Superior trunk and tail ridges produced laterad, margins of rings 3–4, 7–8, 11, 13, 18 and 23 produced as retrorose hooks, remaining rings rounded or bluntly pointed; inferior trunk and tail ridges produced laterad, mar-

gins straight or slightly rounded. Dorsal fin base somewhat elevated; scutella suboval, width on trunk about 5/6 distance between proximal margins of adjacent scutella, about 2/3 this distance on tail; neuromasts present but indistinct. Two pairs of branched cirri on snout; branched cirri also present on: supra and suborbital projections, anterior part of opercular ridge, median frontal ridge; large feather-like cirrus immediately behind each hook like projection on superior trunk and tail ridges; dorsum with rounded, fleshy pads on scutella of 7th and 11th trunk rings, which may represent persistent bases of additional cirri; eye bears circle of 10–12 small, white tabs, with single large, brown flap above and below.

Ground color light tan. Snout, dorsum and upper sides of head lightly and irregularly shaded with brown; pectoral ring mainly brown across upper sides and dorsum; about 4 indistinct bands on trunk, 6 on tail, bands most prominent across dorsum between lateral trunk ridges, less distinct or obsolete on lower sides; interspaces variously flecked with brown; pectoral and dorsal fin bases brownish, fins otherwise pale; caudal fin brown at base, traces of two narrow bars distad; venter immaculate.

*Discussion*: Duncker (1940) described *Phanerotokeus* (type-species *P. gohari* Duncker) from Ghardaqa in the Gulf of Suez without mention of Bamber's (1915) description of *Halicampus macrorhynchus*. Subsequently, Fowler (1956) erected *Halicampoides* on the basis of Bamber's description and figure, but omitted reference to Duncker (1940). Smith (1963) treated *Halicampoides* as a junior synonym of *Phanerotokeus* and placed *P. gohari* in synonymy with *macrorhynchus*. Other references to this species include the description of a dried specimen (as *Phanerotokeus macrorhynchus*) from Eilat by Tortonese (1968), and Botros' (1971) listing as a possible Red Sea endemic (as both *P. gohari* and *Halicampus macrorhynchus*). Duncker (1940) failed to compare his material with *Halicampus* Kaup (1856), and the only characters differentiating *Phanerotokeus* (and *Halicampoides*) appear to be relative lengths of snout and the presence or absence of dermal cirri. Length of snout alone is not a meaningful basis for generic separation among pipefishes and the presence, state of development, or absence of cirri is variable within a species. Herre and Herald (1951) remarked on the relatively long snouts of their specimens of *Halicampus grayi* Kaup [= *H. koilomatodon* (Bleeker)] compared with the specimen figured by Weber and DeBeaufort (1922:103, fig. 43). Snout length is about 2.7 in head length in the figured specimen whereas Herre and Herald reported this ratio as 2.0 for their material. Our examination of *H. koilomatodon* (9, 66–94 mm SL; including two Bleeker specimens, RMNH 7226) shows a 2.1–2.5 range for this character. In addition, there are hooklike protrusions on lateral trunk ridges, ventrolateral projections on the pectoral ring and projections on pectoral cover plate and dorsum of head, which are essentially similar

to those on the fish described here. Body ridge configurations agree in both nominal genera; dorsal fin bases are elevated and the male brood pouch is subcaudal in both, with eggs deposited in cutaneous cells protected by short, lateral folds and poorly developed, protective plates. In the absence of substantial differentiating characters we place *Phanerotokeus* in synonymy with *Halicampus* Kaup.

The Guadalcanal specimen is more robust and deeper bodied than examined Red Sea material [USNM 166931 (8, 120–145 mm SL); MSNH 40551 (1, 155)]. Compared with a 145 mm SL male from Ghardaqa, minimum snout depth is 2.4 mm (against 1.6), minimum snout breadth 1.8 (1.3), maximum head breadth at opercular ridge 8.2 (5.9), maximum breadth at lower pectoral ridge 10.5 (8.6), maximum trunk depth 9.2 (7.3) and maximum trunk breadth 9.0 (7.6). Head and body ridges are much larger and more prominent in the Pacific fish and there are no cirri on the snout of any Red Sea specimens although body cirri are variously present or absent. Mr. Wheeler advises that the holotype of *Halicampus macrorhynchus* (BMNH 1915.10.25.2) lacks cirri on the snout and has somewhat reduced hooklike lateral trunk ridges. Similar hooks occur on some of the examined Red Sea fish, but lateral trunk ridges are mostly straight with but a slight notch near the posterior margins. The holotype and other Red Sea specimens have 26–27 tail rings (25 in Pacific specimen) and subdorsal rings total 3–3.25 (against 2.75), but other meristics of the Pacific specimen fall within the range of examined Red Sea material. We consider the Guadalcanal specimen conspecific with *H. macrorhynchus*; it constitutes the first Pacific record of a species previously thought to be a Red Sea endemic. Additional material may prove observed differences to be constant and subspecific treatment may be warranted for the Pacific population.

## Literature Cited

Bamber, R. C. 1915. Reports on the marine biology of the Sudanese Red Sea, from collections made by Cyril Crossland, M. A., D. Sc., F. L. S.—XXII. The fishes. Jour. Linn. Soc., Zool. 31:38–485, pl. 46.

Botros, G. A. 1971. Fishes of the Red Sea. Oceanogr. Mar. Biol. Ann. Rev. 9:221–348.

Duncker, G. 1940. Ueber einige Syngnathidae aus dem Roten Meer. Publ. Mar. Biol. Sta. Ghardaqa (Red Sea) 3:83–88.

Fowler, H. W. 1956. Fishes of the Red Sea and southern Arabia. Vol. 1. Weitzmann Science Press, Jerusalem. 240 pp.

Herald, E. S. 1953. Family Syngnathidae: Pipefishes. In: L. P. Schultz *et al.* Fishes of the Marshall and Marianas Islands. Bull. U. S. Nat. Mus. 202(1):231–278, figs. 36–44.

———. 1959. From pipefish to seahorse—a study of phylogenetic relationships. Proc. Calif. Acad. Sci., Ser. 4, 29(13):465–473.

——— and J. E. Randall. 1972. Five new Indo-Pacific pipefishes. Proc. Calif. Acad. Sci. 39(11):121–140.

Herre, A. W. and E. S. Herald. 1951. Noteworthy additions to the Philippine fish fauna with descriptions of a new genus and species. Philippine Jour. Sci. 79(3):309–339.

Klausewitz, W. 1972. Litoralfische der Malediven. I. Einleitung und Fische der Ordnung Syngnathiformes (Pisces: Teleostei). Senckenbergiana Biol. 53(3/4):199–217.

Kaup, J. J. 1856. Catalogue of lophobranchiate fish in the collection of the British Museum. Taylor and Francis, London. 76 pp.

Smith, J. L. B. 1963. Fishes of the family Syngnathidae from the Red Sea and the Western Indian Ocean. Ichthyol. Bull. Rhodes Univ. 27:515–543.

Tortonese, E. 1968. Fishes from Eilat (Red Sea). Bull. Sea Fish. Res. Sta., Haifa 51(40):6–30.

Weber, M. and L. F. DeBeaufort. 1922. The fishes of the Indo-Australian Archipelago. E. J. Brill, Leiden 4:i–xiii + 1–410, 103 figs.

Whitley, G. P. 1964. Fishes from the Coral Sea and the Swain Reefs. Rec. Austr. Mus. 26(5):145–195.

'3

QH
1
B4X
NH

). 26, pp. 281–304 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES AUG 21 1975

# THE RELATIONSHIPS OF *HEMICAULODON EFFODIENS* COPE 1869 (MAMMALIA: ODOBENIDAE)

By Clayton E. Ray
*Smithsonian Institution, Washington, D.C. 20560*

## Introduction

In 1965, while reviewing the older literature in connection with studies of fossil pinnipeds of the eastern United States, I happened upon the type-description of *Hemicaulodon effodiens* Cope 1869, described on the basis of an incomplete tusklike tooth thought to be an upper incisor, from a marl pit at Shark River, Monmouth County, New Jersey, as an Eocene sea cow, but obviously, from a glance at Cope's excellent illustrations, the basal part of the tusk of an advanced, probably Pleistocene, walrus. As the name seemed not to have entered into the literature of fossil walruses, a search was made to learn its disposition, revealing that for the most part it had been overlooked or ignored, for example in otherwise comprehensive modern works on the Mammalia (Simpson, 1945), on the Sirenia (Simpson, 1932; Reinhart, 1959), and on fossil vertebrates of New Jersey (Miller, 1955). When noticed at all, it generally has been mentioned or listed as an Eocene sirenian: without question, by Gervais (1872a, p. 169; 1872b, p. 352), Cope (1883, p. 52; 1890, p. 699, as *Hemicaulodon effodens*), Heilprin (1887, p. 340), Roger (1887, p. 30, as from South Carolina, in error), Trouessart (1898, p. 1006; 1905, p. 751), Hay (1902, p. 583; 1930, p. 657), Rhoads (1903, p. 246), and Palmer (1904, p. 316); with question, by Lepsius (1882, p. 185), Zittel (1893, p. 201, listed incertae sedis, as an inadequately founded genus), Roger (1896, p. 249, incertae sedis, as from South Carolina, in error), and Allen (1923, p. 231). Leidy (1869, p. 440), followed by Brandt (1873, p. 290),

placed *Hemicaulodon effodiens* among the toothed whales, but with characteristic astuteness, implied that it might represent a walrus-like animal, just as might *Ontocetus emmonsi*, about which he was quite correct also (Ray, in press). Kellogg (1924, p. 757) regarded the allocation of *H. effodiens* as "too uncertain at present for any discussion of its possible relationships," but seemed to imply cetacean or sirenian affinities, whereas he later (1966, p. 78) regarded it definitely as a dugongid sirenian. Reinhart (in press) concurs that it is a walrus. To my knowledge the above include all published indications of relationship of *Hemicaulodon effodiens*. Several citations of the name (Roger, Trouessart, and Rhoads) give its year of publication erroneously as 1871, which is the year indicated on the title page of whole volume XI of the Proceedings of the American Philosophical Society, but not of part No. 82 therein, which was published in 1869.

The present notes are published now in order to make them available to others engaged in the completion of relevant comprehensive studies, and to call attention to the taxon in the hope that its type-specimen may be rediscovered.

## Fate of the Holotype

Sporadic efforts from 1965 to the present to find the holotype have thus far failed to locate it in the collections of the following institutions: Academy of Natural Sciences of Philadelphia (ANSP); American Museum of Natural History (AMNH); Monmouth County Historical Association Museum; National Museum of Natural History (USNM); New Jersey State Museum; Peabody Museum of Natural History, Yale University; Princeton University, Department of Geology; Rutgers, the State University, Department of Geology.

The specimen was originally in the private collection of the Reverend Samuel Lockwood, an avid amateur naturalist, who was for 15 years pastor in Keyport, New Jersey, before resigning in August, 1869, and moving to Freehold in 1870 (John Enright, 1885, p. 449). There is no certainty that Cope ever had the specimen in his possession, and, although explicit information is lacking, there is considerable circumstantial evidence that he did not, based upon the sequence of events re-

lating to the description of *Ornithotarsus immanis*, a very large hadrosaur, that commanded greater attention in publication, correspondence, and records.

Although quoted already by Lull and Wright (1942, p. 4), Lockwood's colorful account of a visit from Cope, apparently only a few days prior, will stand repeating for its bearing on *Hemicaulodon*:

> Just as I was about packing the bone [of *Ornithotarsus immanis*] to send to Mr. H. [Waterhouse Hawkins] (I actually had it in the box) a gentleman knocked at the door. He had a very large carpet bag and announced himself as Prof. Cope. He had smelt the bone & come for it. But no sir that could not be. Well, he would see it & see it he did, & took drawings of it. Thus [?] I found this stranger a remarkable man. If the sibyl could declare in dubious language Alexander is invincible, I can say literally as regards Prof. Ed. C. that this humble individual could not cope with him. He is the man to seize your very bones. (Marsh correspondence, Peabody Museum, letter from Lockwood to Marsh of May 20, 1869).

Cope exhibited the drawings and introduced the scientific name at a meeting of the Academy of Natural Sciences of Philadelphia on June 1, 1869. He introduced *Hemicaulodon* in the Proceedings of the American Philosophical Society for July 16 of the same year, probably after having made drawings and notes during the same visit to Lockwood. At about the same time Lockwood did however lend Cope for description a plesiosaur vertebra, which became the type of *Plesiosaurus lockwoodii* (see Welles, 1952, p. 113, for citations to the confusing literature).

Thus Cope described at least three taxa from Lockwood's collections. Of these, at least one, *Ornithotarsus immanis*, became part of the Marsh collections at the Peabody Museum, having been sent by Lockwood on March 16, 1886, and received on March 18, 1886, according to the records under Accession No. 1830. The shipment consisted of only "one box (express $1.00) containing type specimen of *Ornithotarsus immanis* Cope. . . .," with no reference to other material. The

only explicit reference to *Hemicaulodon* found in the Marsh correspondence is in a list of specimens enclosed with a letter from Lockwood to Marsh of March 21, 1886, in which *Plesiosaurus lockwoodii* is listed as well, indicating that both were still in Lockwood's possession at that time. Whether these were purchased subsequently by Marsh seems to be unknown, though probable. Kellogg's (1966, p. 78) footnote indicating that the type was purchased by Marsh in March 1886 was based upon my findings in the Marsh correspondence, which were not as conclusive as his statement suggests. In any case, none of the specimens has been found in the Peabody Museum in repeated searches by several individuals since 1965.

Rhoads (1903, p. 247) stated, "Type may be in Amer. Mus. Nat. Hist., N. York," perhaps on the basis of the purchase of the Cope Collection of North American fossil mammals by the American Museum of Natural History in 1895 (Osborn, 1931, p. 446). There is no positive evidence that the specimen was included in this collection, and apparently it is not now in the American Museum.

## Characteristics of the Holotype

Although, without the holotype in hand (and possibly even with it), a firm decision as to its specific affinities cannot be made, its identity as the basal, intra-alveolar portion of the tusk of a modernized walrus is evident by inspection of Cope's excellent illustrations, here reproduced, enlarged to natural size (Pl. 1 and Pl. 6, Fig. 3). Cope (1869, pp. 190–191) noted essentially all of the salient features of the holotype that make it distinctively odobenid, and distinctively not sirenian or cetacean, and even compared it to the odobenids *Trichecodon* Lankester and *Ontocetus* Leidy, the latter unfortunately regarded by him at the time as sirenian. His failure to reach the correct conclusions from his keen observations of pertinent characters may be traced primarily to the assumption of Eocene age, to the erroneous belief that the tooth was essentially complete with a part of the triturating surface preserved, and to the paucity of comparative material. The

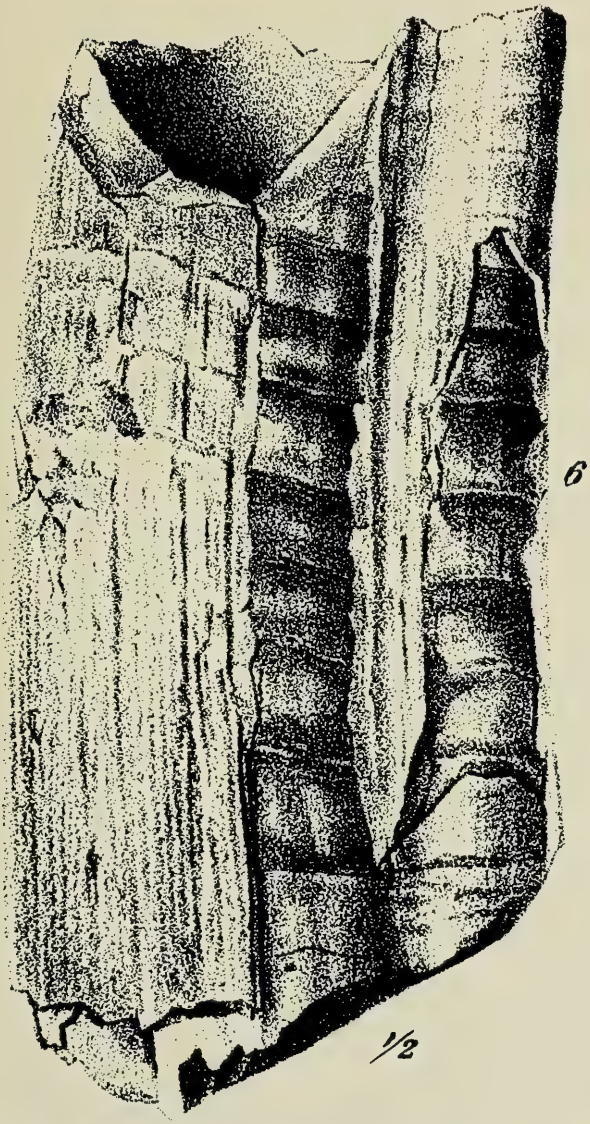



PLATE 1. The holotype of *Hemicaulodon effodiens* in medial (?) aspect. After Cope, 1869, Pl. V, Fig. 6. Original × ½, here enlarged to approximately × 1.

characteristics of the tooth may be discussed conveniently under the general topics of structure, form, and surficial features.

*Structure*: As Cope illustrated and aptly stated, "The substance of the tooth is composed of a large axis of osteo-dentine surrounded by a broad cylinder of dentine, which is in turn surrounded by a thick stratum of cementum. . . . The cementum is everywhere entire, and is thicker distally. . . . The dentinal layer is about one half the thickness of the osteodental axis, and three times that of the cementum." The discrete, flattened-cylindrical core of globular osteodentine extending the length of the tusk is alone enough to exclude the specimen from all other Mammalia, and to identify it conclusively as odobenid (Pls. 3 and 6). Globular osteodentine probably occurs sporadically in many, if not most, groups of mammals, but is especially common in some forms with large tusklike teeth, including wart hogs (Penniman, 1952, Pl. XIII), dugongs (Pl. 5, Fig. 2), elephant seals (Pl. 5, Fig. 1), and odontocetes, especially sperm whales (Boschma, 1938, Pl. XIII; Pl. 4). Its occurrence and abundance in these groups seems to be variable, but, in elephant seals and sperm whales at least, it tends to be more prevalent in old individuals. In sperm whales the globules occur singly or in intergrown clumps in the soft tissue of the pulp cavity, where they may ultimately become imbedded here and there within successive layers of the dentinal laminae, possibly in part in annual pulses, but apparently never as a well-defined subcylindrical mass extending the length of the tooth. Occurrence in the modern dugong is negligible. The canines of old male elephant seals show the closest approach to those of walruses in development of globular osteodentine, but even there it occurs mostly as isolated lumps within the laminar dentine with at most a cone-shaped mass in part filling the pulp cavity in old

---

→

PLATE 2. Basal part of right tusk of Pleistocene *Odobenus rosmarus* in medial aspect, USNM 24886, dredged off North Carolina. Cementum spalled away from most of surface, revealing transverse annular ridges. × 1.

24896

age (as in a sectioned right upper canine of USNM 265353, an old male of *Mirounga angustirostris*, Pl. 5, Fig. 1).

In the course of his original description of *Trichecodon huxleyi*, Lankester (1865, pp. 228–230, Pl. 10, Figs. 4–6) clearly defined and illustrated the unique development of globular osteodentine in walrus tusks, noting that it was described as early as 1805 by Cuvier. Although Cope obviously had Lankester's paper at hand while describing *Hemicaulodon*, neither he nor apparently most authors who have studied isolated fossil teeth of marine mammals to date recognized the utility of this feature in identifying walrus tusks.

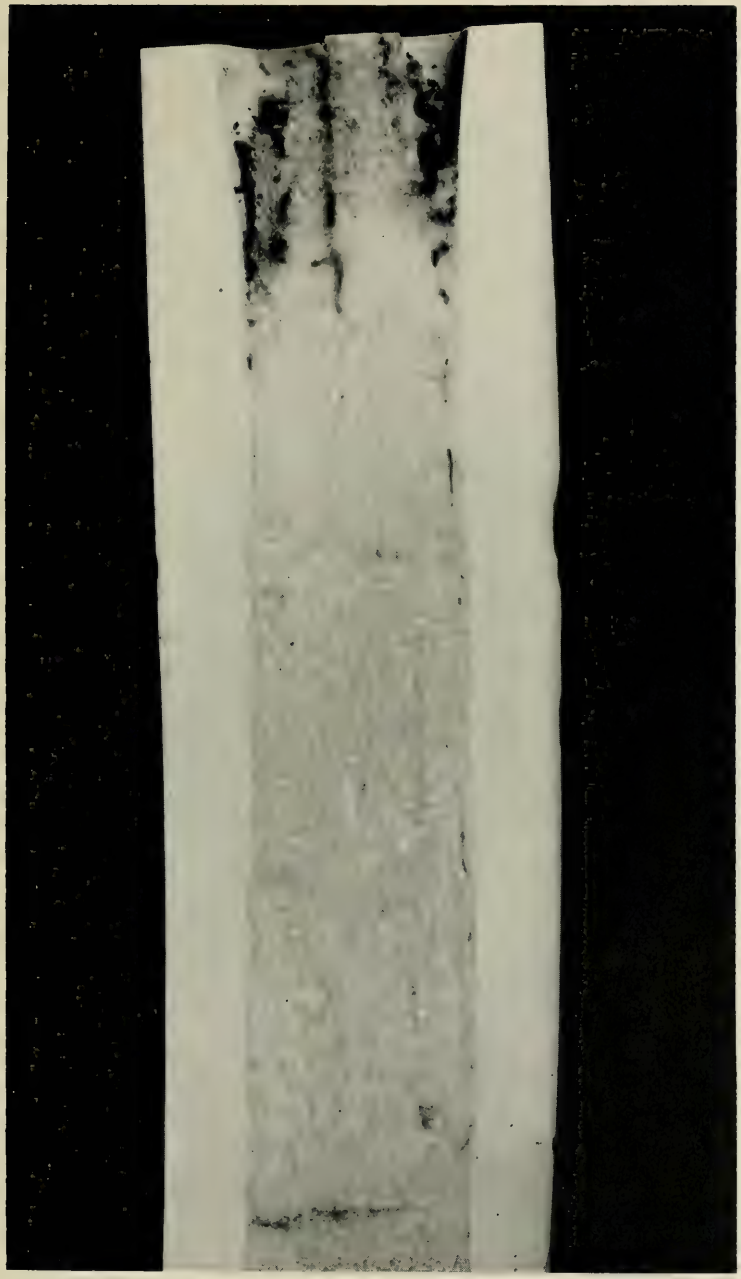
As Cope pointed out, the tusk of *Hemicaulodon* differs from those of dugong and *Rytiodus* in having a complete sheath of cementum and no enamel band. The tusks of modernized walruses have only a short apical cap of enamel that is worn entirely away within the first few years of life (Mansfield, 1958, pp. 25–28, Fig. 5).

*Form*: Cope recognized the following salient features: "The form of the tooth is that of a compressed, slightly curved cylinder, with distal and proximal vertical diameters equal. . . . The transverse diameter posteriorly is less than that anteriorly. . . . The widths of the tooth increase very little from the basis to the worn surface." All of these characters and those revealed in the illustrations are appropriate to walrus tusks, and for the most part not to sirenian tusks. The posterior narrowing of the holotype in cross section is atypical of walrus tusks, but not unknown. The tusks of *Hemicaulodon effodiens* and *Rytiodus capgrandi*, with which Cope compared his specimen especially, are shown together in lateral and cross-sectional aspects by Gervais (1872b, Pl. XIX, Figs. 1, 1a, 2, 2a), revealing clearly their dissimilar shapes, the tusk of *Rytiodus* being irregular and noncylindrical in shape with varied transverse dimensions along its length, curved conspicuously in two planes, and extremely compressed. Tusks

---

→

PLATE 3. Longitudinally sectioned basal part of right tusk of Recent *Odobenus rosmarus* in internal aspect, USNM 21667, showing core of globular osteodentine. × 1.



of modern dugongs are superficially similar to the incisors of rodents in general form, with more nearly equal transverse diameters, none of which approach those of *H. effodiens* or modern walrus tusks in size.

The ratio of least to greatest diameters (.61) of the holotype tusk is rather low for *Odobenus rosmarus*, though not outside its observed range, reflecting a degree of flattening more characteristic of tusks from late Tertiary beds (Ray, in press).

Cope contrasted the acuminate form of the tusks of *Trichecodon* and *Ontocetus* with the cylindrical form of that of *H. effodiens*. This unjustified emphasis of correct observations was based on the fact that his specimen represented the proximal, and the others, the distal, parts of walrus tusks. This misinterpretation is directly related to another, i.e., the supposition that his specimen represented a nearly complete tooth in which "a portion of the triturating surface is preserved; it truncates the tooth upwards and backwards in relation to its axis, as would be anticipated in a superior incisor [of a sirenian]." In fact the holotype represents only the proximal, intra-alveolar end of a walrus tusk. The "triturating surface" could indeed have developed in life in an individual walrus with a broken canine, a not uncommon accident among living walruses (Cousteau and Diolé, 1974, p. 174). The polished surface could equally well have been a postmortem phenomenon, judging from experience with other fossil walrus tusks. The durable rostrum of the skull will often remain intact through extensive rolling and abrasion, after the cranium has been separated or destroyed and the tusks broken off near the alveolar borders, and their stubs polished, yielding a "triturating surface" in approximately the right position and orientation for *H. effodiens*. Further tumbling might then break up the rostrum or cause the basal tusk frag-

---

→

PLATE 4. Longitudinally sectioned tooth (distal 6 cm not shown) of Recent *Physeter catodon* in internal aspect, USNM 25653, showing irregularly distributed globules of osteodentine. × 1.

256523
23938

ment to slip out of its alveolus. Whether broken and polished in life or death, the proximal end of the tusk represented is typically walrus-like and could not be expected to show the acuminate form of the extruded distal end.

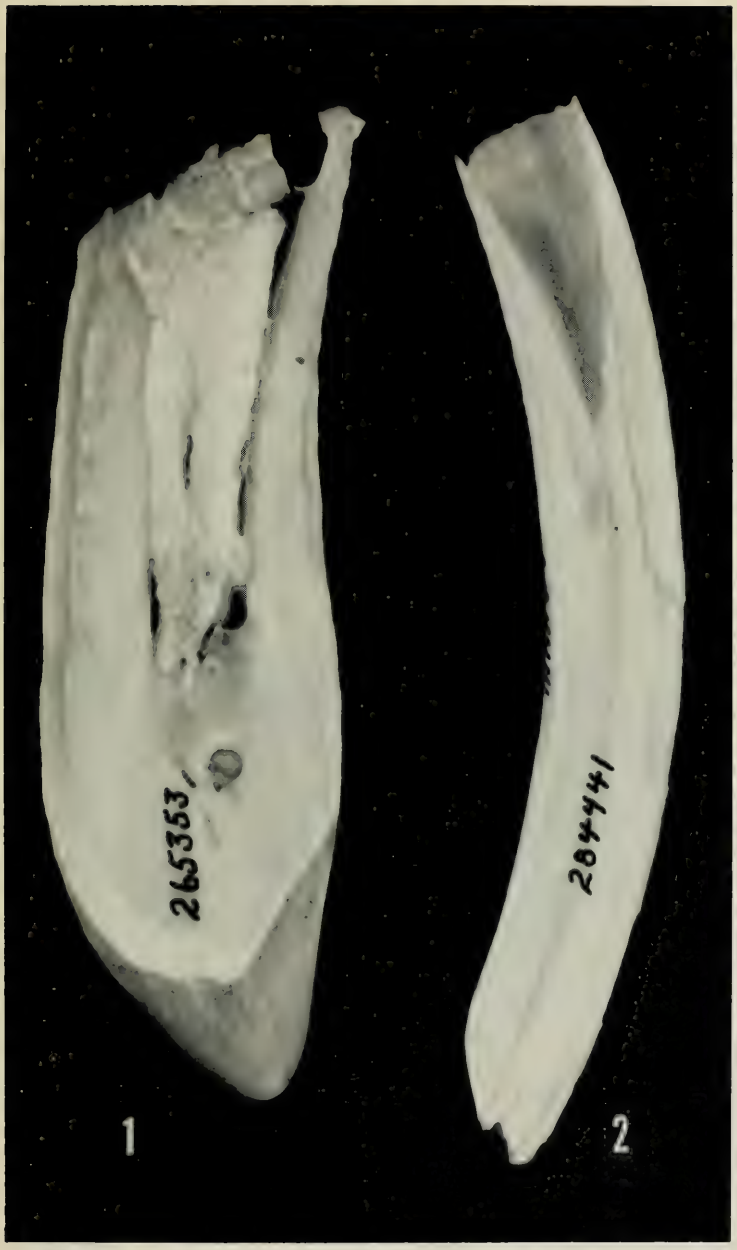
*Surficial Features*: These include "two open grooves on the inner and one similar on the outer side, the former enclosing a broad bead. . . . The dentine . . . marked at regular distances by annuliform ridges, which are more or less undulate. They become gradually more distant distally. These ridges can be traced through the cementum" (Cope, 1869, p. 190). The open grooves, two inner and one outer, are highly characteristic of walrus tusks, as are the transverse dentinal ridges. These ridges were described by Tomes (1904, pp. 195–196) who seems to have been the first to recognize that they reflect annual increments of growth, farther apart in youth (distal) and progressively closer in old age (proximal). They tend to be masked by cementum in unweathered tusks, both fossil and modern, except toward the proximal, intra-alveolar end—hence not apparent in the distal fragments of tusks of *Trichecodon* of Lankester (1865), but reflected in the cementum of Cope's proximal fragment. This condition is shown exceptionally well in modern tusks illustrated by Scheffer (1950, Fig. 3) and by Mansfield (1958, Fig. 7), but the ridges show best in weathered tusks in which some of the cementum has spalled cleanly away from the underlying dentine (Pls. 1 and 2; Brooks, 1954, Fig. 7; Mansfield, 1958, Fig. 8a).

Only Kellogg's (1966, p. 78) comparisons and conclusions regarding *Hemicaulodon* now require comment. He recorded three isolated teeth as incisor tusks of dugongids: USNM

---

→

PLATE 5. Fig. 1, longitudinally sectioned right upper canine of Recent old male *Mirounga angustirostris* in internal aspect, USNM 265353, showing isolated globules of osteodentine, and basal cone of osteodentine filling pulp cavity, × 1. Fig. 2, longitudinally sectioned left tusk (upper incisor) of Recent adult male *Dugong dugon* in internal aspect, USNM 284441, showing small amount of osteodentine embedded in laminar dentine near apex of pulp cavity, × 1.


265353
204441
1
2

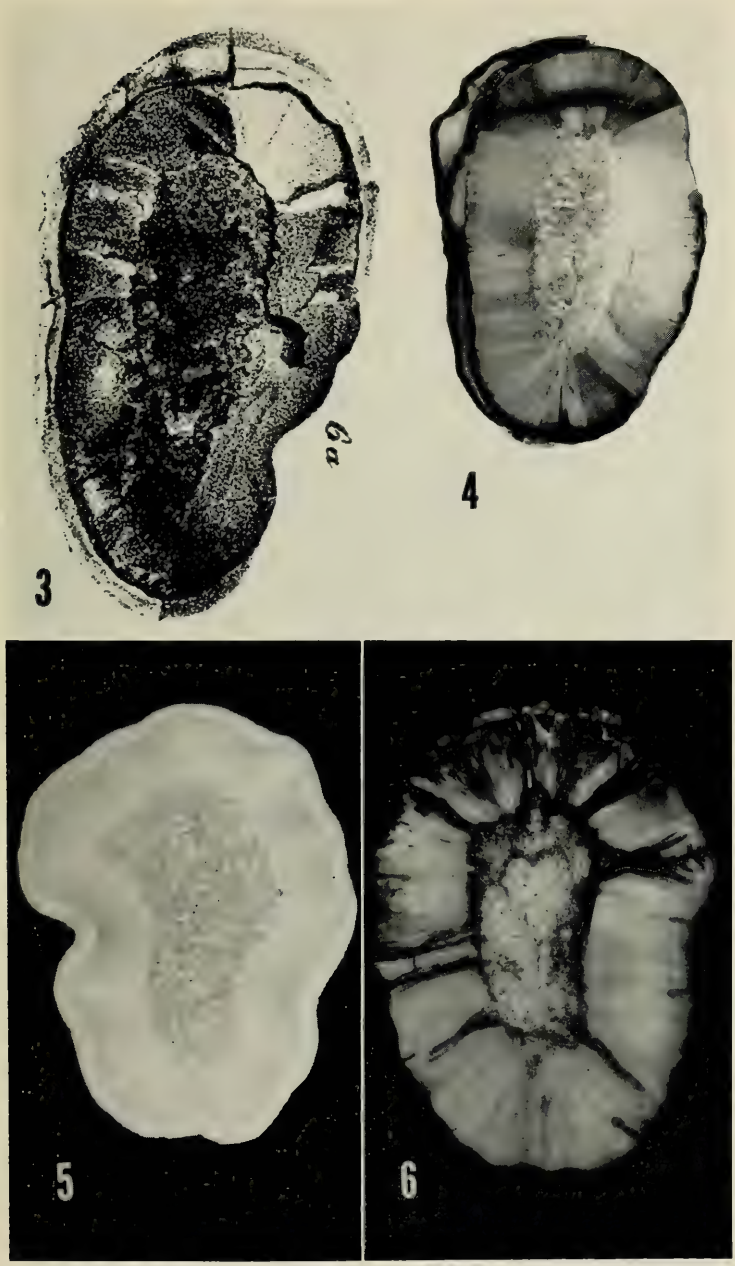
9457, possibly from the Calvert Formation, Tar Bay, Virginia; AMNH 9852 (cast in USNM), dredged off Fort Myers, Florida; USNM 23110 (cast), probably from the Duplin Formation, near Savannah, Georgia. He felt that the major features, except size, of *Hemicaulodon effodiens* could be matched by USNM 9457 and by AMNH 9852. In fact, in addition to disparate size, these teeth differ from the holotype of *H. effodiens* also in lacking the osteodentinal core, the strong, widely spaced transverse dentinal ridges (fine, closely spaced transverse striae are present), and the compressed cylindrical shape with two inner and one outer groove (the transverse dimensions are subequal). All of these teeth can be matched within the variation of a large series of physeterid teeth from the Yorktown Formation of the Lee Creek Mine, North Carolina, and in my opinion represent sperm whales, not sirenians, and in any case bear little resemblance to *H. effodiens*.

Dr. Kellogg (1966, p. 78) perpetuated Cope's comparison of *Hemicaulodon effodiens* to *Rytiodus capgrandi*, but he informed me in subsequent discussion that he had been misled by the unfortunate juxtaposition in Cope's Plate V, of Figure 6, the holotype of *H. effodiens*, and Figure 4a, a human implement made from the shell of *Strombus gigas* from Anguilla, Lesser Antilles. This error caused him to visualize the former as much more compressed and therefore more like the tusk of *R. capgrandi* than is the case. When shown the illustrations of *H. effodiens* enlarged to natural size alongside known walrus tusks with cementum exfoliated, he readily agreed that *H. effodiens* is indeed a walrus (personal communication, 1966).

---

→

PLATE 6. Fig. 3, the holotype of *Hemicaulodon effodiens* in distal aspect, after Cope, 1869, Pl. V, Fig. 6a, original × ½, here enlarged to approximately × 1. Fig. 4, left tusk of Pleistocene *Odobenus rosmarus* transversely sectioned 11 cm from base, in distal aspect, ANSP uncatalogued specimen, dredged off New Jersey, × 1. Fig. 5, left tusk of Recent *O. rosmarus* transversely sectioned 15 cm from base, in distal aspect, USNM 219054, × 1. Fig. 6, right tusk of Pleistocene *O. rosmarus* transversely sectioned 16 cm from base, in distal aspect, USNM 24886, × 1.


3
6a
4
5
6

### Type-Locality

With regard to the type-specimen Cope (1869, p. 191) stated that Lockwood "obtained it from the Eocene marl pits at Shark River, Monmouth co." Lockwood also indicated the locality as "Shark River" in his list sent to Marsh on March 21, 1886. Neither specified whether he referred to the River itself or to the settlement of the same name. However, in a letter to Marsh of November 17, 1881, Lockwood wrote, "I send you a small bone by mail. It was obtained in the Miocene marl, or green sand, at Shark River, Monmouth Co., N. Jersey (now known as Hamilton)." The village continues to be known as Hamilton, and is situated on the north side of the Shark River at approximately 40°12′30″ N, 74°05′ W, in the Asbury Park, New Jersey, quadrangle, U.S. Geological Survey, 7.5 minute series. Hamilton, formerly Shark River, is not to be confused with Shark River Station, which appears on some contemporary maps, sometimes with the word Station omitted. Shark River Station was a stop on the Central of New Jersey Railroad. It no longer appears as such on maps, but was located some 5.5 km WNW of Hamilton, where the still-existing Shark River road terminates at the railroad, in the northwest corner of the township of Wall, 1.1 km northward from Earle, in the Farmingdale quadrangle. Hamilton is somewhat less than 3.2 km upstream from the Shark River estuary, and the principal 19th century marl pits nearest to Hamilton were concentrated near the River some 1.6–3.2 km still farther upstream, immediately SW and W of interchange no. 100 of the Garden State Parkway (Cook, 1868, pp. 275–276; Ralph Johnson and Robert W. Purdy, personal communication). The locality probably cannot be established more accurately than "marl pit, near Hamilton, Monmouth County, New Jersey.

### Geologic Age

The general geology along the Shark River near Hamilton is probably permissive of a source for *Hemicaulodon effodiens* in Eocene, Miocene, or Pleistocene strata. Cook (1868, pp. 275–276, Fig. 71) gives a section of a typical marl pit of the time along the Shark River, the J.T.L. Tilton pit, apparently

the pit closest to Hamilton (Robert W. Purdy, personal communication). The Eocene deposit here is the Shark River marl, an argillaceous glauconite sand, regarded by some authors in recent years as a member of the Manasquan Formation, but separated and redefined as the Squankum Member of the Shark River Formation by Richard Enright (1969, p. 18). The Eocene strata are overlain disconformably in the area by the Asbury Park and Grenloch Sand Members of the Miocene Kirkwood Formation, generally regarded on sparse paleontological evidence as in part equivalent to the Calvert Formation of Maryland (Isphording, 1970). The Grenloch Sand Member may not be readily separable from the overlying Cohansey Sand, which may or may not extend into Monmouth County (Markewicz, 1969). Pleistocene (?) gravels probably pertaining to the Pennsauken Formation are widespread in the area (Salisbury and Knapp, 1917, pp. 155–156; Bowman and Lodding, 1969) and at least around the Shark River estuary, as at Neptune City, there are thick late Pleistocene marine deposits. The recognition, distribution, geologic age, correlation, and paleoecology (marine vs. nonmarine) of all strata from the Kirkwood Formation upward remain uncertain, but all have been regarded at times as in part or in whole nonmarine, based in large measure upon the dearth of fossils.

In the original publication on *Hemicaulodon effodiens* Cope (1869, p. 191) indicated only that it was from the "Eocene marl pits," but in 1872 (p. 14) he noted that the Eocene "near to Shark River especially, [is] overlaid by a thin stratum of loamy sand, which contains fragmentary remains of terrestrial vertebrates of the Miocene period. . . . Whether . . . *Hemicaulodon* (Cope) and *Anchippodus* (Leidy) were derived from this or from the Eocene bed remains uncertain." Kellogg (1966, p. 78), unduly influenced by supposed similarities of the type of *H. effodiens* to later Tertiary specimens from eastern United States and to the tusks of *Rytiodus capgrandi*, stated as follows: "It is now suggested without hesitation that the type tooth was not derived from the middle Eocene Shark River marl. . . . Inasmuch as the Miocene Kirkwood formation overlaps the Shark River marl (Manasquan Formation), the

association of any specimen picked up on the surface alongside or in a marl pit being worked could readily be misinterpreted." Lockwood (1885, p. 15), in his account of the paleontology of Monmouth County, stated that, "In the so-called Drift, one phase of the glacial period, we have collected in Monmouth County relics of the reindeer, walrus, and even a species of dugong." Throughout the publication Lockwood referred to himself in the plural, including explicit reference to his collecting the types of *Ornithotarsus immanis* and *Plesiosaurus lockwoodii*. The "species of dugong" could hardly apply to anything but *Hemicaulodon effodiens*, and suggests that Lockwood had come to suspect a Pleistocene age. Remains of Pleistocene walruses were recognized early along the coast of New Jersey (Leidy, 1857), and they continue to accumulate in substantial numbers (Kardas, 1965, and unpublished specimens). Donald Baird (personal communication) has pointed out that bones of *Mammut americanum* were recovered from the same spoil heap as the Cretaceous reptiles of New Jersey reported by Baird and Case (1966). This situation is familiar to anyone accustomed perforce to working with vertebrate remains from ditches, road cuts, dredgings, and spoil in the outer coastal plain with its low relief, deep weathering, poor exposures, and thin, unconsolidated deposits reflecting complex geologic history.

My interpretation of the affinities of *H. effodiens* would suggest a maximum age no earlier than the deposition of the Yorktown Formation, the source of the otherwise oldest known walruses in the Atlantic Coastal Plain. Thus the Shark River Formation, which antedates the origin of pinnipeds, is out of the question as a possible source, and even the Calvert-equivalent Kirkwood Formation is too old, barring the improbable possibility that *H. effodiens* is the oldest North Atlantic walrus by a considerable margin. The morphology of the specimen, so far as revealed in the original illustrations, does not serve to differentiate among Yorktown and younger walruses. In view of this and of the inexact type-locality and of uncertain identification and correlation of the later Cenozoic beds in the area, it is futile to speculate further about the geologic age of *H. effodiens*, at least until the type is found.

## Conclusion

*Hemicaulodon effodiens* is definitely an advanced walrus on the basis of all details of structure, shape, size, and annulations of the type tusk. Similar tusks are known from the Yorktown to the Recent in and around the North Atlantic.

The most convenient and reasonable disposition of the taxon for the present is as a Pleistocene (?) representative and junior synonym of *Odobenus rosmarus*, with the proviso that its placement should be reappraised on the basis of morphology and possibly adherent matrix (noted by Cope, 1869, p. 190, in the pulp cavity) when the type is relocated.

## Acknowledgments

I wish particularly to acknowledge my debt to the late Remington Kellogg who listened patiently, responded flexibly, and encouraged publication of these findings. I wish also to thank the curators and staff of the various museums and institutions in which the type-specimen of *H. effodiens* or information about it has been sought. In addition certain individuals must be thanked individually for their extraordinary assistance. Foremost among these is Robert W. Purdy, who has shared his special knowledge of the paleontology and history of Monmouth County and has explored numerous leads in our search. Similarly, Donald Baird, James A. Hopson, Ralph Johnson, and John S. McIntosh, have provided useful information and suggestions. Louise Jost, Librarian of the Monmouth County Historical Association, Harmony Coppola, Secretary to the Archivist, Rutgers, the State University, and Melvin C. Krampf, historian, and columnist of the Freehold Transcript, have been extraordinarily helpful in seeking information about Samuel Lockwood. Charles O. Handley, Jr., and James G. Mead made the collections of Recent marine mammals of the National Museum of Natural History available, and permitted sectioning of selected specimens. The plates were prepared by Lawrence B. Isham from photographs taken by Victor E. Krantz. The manuscript was reviewed by Roy H. Reinhart and Frank C. Whitmore, Jr. The work on which this paper is based was supported by the Smithsonian Institu-

tion, in part through the Remington Kellogg Memorial Fund and in part through the Smithsonian Research Foundation.

## Literature Cited

Allen, G. M. 1923. Additional remains of the fossil dugong of Florida. Jour. Mammal. 4(4):231–239, pl. 26, 1 text-fig.

Baird, D. and G. R. Case. 1966. Rare marine reptiles from the Cretaceous of New Jersey. Jour. Paleontol. 40(5):1211–1215, text-figs. 1–3.

Boschma, H. 1938. On the teeth and some other particulars of the sperm whale (*Physeter macrocephalus* L.). *Temminckia* 3: 151–278, pls. 10–13, text-figs. 1–19.

Bowman, J. F., II and W. Lodding. 1969. The Pennsauken Formation—A Pleistocene fluvial deposit in New Jersey, pp. 3–6, text-fig. 1. *In* S. Subitzky (ed.). Geology of selected areas in New Jersey and eastern Pennsylvania and guidebook of excursions. Rutgers Univ. Press, New Brunswick, New Jersey.

Brandt, J. F. 1873. Untersuchungen über die fossilen und subfossilen Cetaceen Europa's. Mém. Acad. Imp. Sci. St.-Pétersbourg, Ser. 7, 20(1):I–VIII, 1–372, pls. 1–34.

Brooks, J. W. 1954. A contribution to the life history and ecology of the Pacific walrus. Alaska Coop. Wildl. Res. Unit, Spec. Rep. 1:viii + 103 pp., text-figs. 1–9.

Cook, G. H. 1868. Geology of New Jersey. [New Jersey State] Board of Managers, Newark, xxiv + 899 pp., figs.

Cope, E. D. 1869. Synopsis of the extinct Mammalia of the cave formations in the United States, with observations on some Myriapoda found in and near the same, and on some extinct mammals of the caves of Anguilla, W. I., and of other localities. Proc. Amer. Philos. Soc. 11(82):171–192, pls. 3–5.

———. 1872. List of the Reptilia of the Eocene formation of New Jersey. Proc. Acad. Nat. Sci. Phila. 1872:14–18.

———. 1883. On a new extinct genus of Sirenia, from South Carolina. Proc. Acad. Nat. Sci. Phila. 1883:52–54.

———. 1890. The extinct Sirenia. Amer. Natur. 24(284):697–702, pls. 25–26, text-figs. 1–3.

Cousteau, J.-Y. and P. Diolé. 1974. Sea lion, elephant seal, walrus. Cassell & Co., London, 304 pp.

Enright, J. 1885. Samuel Lockwood, Ph.D., pp. 444–450, 1 text-fig. *In* F. Ellis, History of Monmouth County, New Jersey. R. T. Peck & Co., Philadelphia. [Reprinted 1974. Polyanthos, Inc., Cottonport, Louisiana.]

Enright, R. 1969. The stratigraphy and clay mineralogy of the Eocene sediments of the northern New Jersey coastal plain, pp. 14–20, text-figs. 1–2. *In* S. Subitzky (ed.). Geology of selected areas in New Jersey and eastern Pennsylvania and

guidebook of excursions. Rutgers Univ. Press, New Brunswick, New Jersey.

Gervais, P. 1872a. Analyses d'ouvrages et mémoires. XVIII.—Cope (E.D.): diverses notes relatives aux mammifères fossiles et aux myriapodes des États-Unis. Jour. Zoologie 1:168–170, 1 text-fig.

———. 1872b. Analyses d'ouvrages et mémoires. XXXVIII.—Travaux récents sur les sirénides vivants et fossiles. Jour. Zoologie 1:332–353, pls. 18–19, text-figs. 1–4.

Hay, O. P. 1902. Bibliography and catalogue of the fossil Vertebrata of North America. U.S. Geol. Surv. Bull. 179:868 pp.

———. 1930. Second bibliography and catalogue of the fossil Vertebrata of North America. Carnegie Inst. Washington Publ. 390, vol. 2:XIV + 1074 pp.

Heilprin, A. 1887. The geographical and geological distribution of animals. Internat. Sci. Ser., vol. 57, D. Appleton and Co., New York, xii + 435 pp.

Isphording, W. C. 1970. Petrology, stratigraphy, and re-definition of the Kirkwood formation (Miocene) of New Jersey. Jour. Sed. Petrol. 40(3):986–997, text-figs. 1–8.

Kardas, S. J., Jr. 1965. Notas sobre el género *Odobenus* (Mammalia, Pinnipedia). 1. Una nueva subespecie fósil del Pleistoceno superior-Holoceno. Bol. Real Soc. Española Hist. Nat. (Biol.), Madrid. 63(4):363–380, text-figs. 1–7.

Kellogg, R. 1924. Tertiary pelagic mammals of eastern North America. Bull. Geol. Soc. Amer. 35(4):755–766.

———. 1966. New species of extinct Miocene Sirenia. U.S. Nat. Mus. Bull. 247(3):65–98, pls. 33–43, text-figs. 32–38.

Lankester, E. R. 1865. On the sources of the mammalian fossils of the red crag, and on the discovery of a new mammal in that deposit, allied to the walrus. II. *Trichecodon Huxleyi*, a new mammalian fossil from the red crag of Suffolk. Quart. Jour. Geol. Soc. London 21(1):226–232, pls. 10–11, figs. 1–2.

Leidy, J. 1857. Notice of remains of the walrus discovered on the coast of the United States. Trans. Amer. Philos. Soc., New Ser. 11(5):83–86, pls. 4–5, fig. 1.

———. 1869. Synopsis of extinct Mammalia of North America. Jour. Acad. Nat. Sci. Phila. Ser. 2, 7:363–446, pls. 28–30.

Lepsius, G. R. 1882. *Halitherium Schinzi*, die fossile Sirene des mainzer Beckens. Abhandl. Mittelrheinischen Geol. Vereins 1:IV + 200 + VIII pp., pls. 1–10.

Lockwood, S. 1885. Archaeology and Paleontology, pp. 7–16. *In* F. Ellis. History of Monmouth County, New Jersey. R. T. Peck & Co., Philadelphia. [Reprinted 1974. Polyanthos, Inc., Cottonport, Louisiana.]

Lull, R. S. and N. E. Wright. 1942. Hadrosaurian dinosaurs of North America. Geol. Soc. Amer. Spec. Pap. 40:xi + 242 pp.

Mansfield, A. W. 1958. The biology of the Atlantic walrus *Odobenus rosmarus rosmarus* (Linnaeus) in the eastern Canadian Arctic. Fish. Res. Board Canada, Ms. Rept. Ser. (Biol.) 653:xiii + 146 pp., text-figs. 1–35.

Markewicz, F. J. 1969. Ilmenite deposits of the New Jersey coastal plain, pp. 363–382, text-figs. 1–13. *In* S. Subitzky (ed.). Geology of selected areas in New Jersey and eastern Pennsylvania and guidebook of excursions. Rutgers Univ. Press, New Brunswick, New Jersey.

Miller, H. W., Jr. 1955. A check-list of the Cretaceous and Tertiary vertebrates of New Jersey. Jour. Paleontol. 29(5):903–914.

Osborn, H. F. 1931. Cope: master naturalist. Princeton Univ. Press, Princeton, New Jersey, xvi + 740 pp.

Palmer, T. S. 1904. Index Generum Mammalium: A list of the genera and families of mammals. U.S. Dept. Agriculture, Div. Biol. Surv., North American Fauna 23:984 pp.

Penniman, T. K. 1952. Pictures of ivory and other animal teeth, bone and antler, with a brief commentary on their use in identification. Univ. Oxford, Pitt Rivers Mus., Occ. Pap. Technol. 5:40 pp., 20 pls.

Ray, C. E. (In press). Seals and walruses (Mammalia:Pinnipedia) of the Yorktown formation of Virginia and North Carolina. Smithsonian Contrib. Paleobiol.

Reinhart, R. H. 1959. A review of the Sirenia and Desmostylia. Univ. Calif. Publ. Geol. Sci. 36(1):1–146, pls. 1–14, text-figs. 1–19.

———. (In press). Fossil Sirenia and Desmostylia of Florida and elsewhere. Bull. Florida State Mus., Biol. Sci.

Rhoads, S. N. 1903. The mammals of Pennsylvania and New Jersey. Privately published, Philadelphia, 266 pp.

Roger, O. 1887. Verzeichniss der bisher bekannten fossilen Säugethiere. (Zusammengestellt von Dr. Otto Roger.). Ber. Naturwiss. Vereins Schwaben u. Neuburg (a. V.). 29:162 pp.

———. 1896. Verzeichniss der bisher bekannten fossilen Säugethiere. (Neu zusammengestellt von Dr. Otto Roger, etc.). Ber. Naturwiss. Vereins Schwaben u. Neuburg (a. V.). 32:272 pp.

Salisbury, R. D. and G. N. Knapp. 1917. The Quaternary formations of southern New Jersey. Rept. Dept. Conserv. Development, Final Rept. Ser. State Geologist 8:vii + 218 pp.

Scheffer, V. B. 1950. Growth layers on the teeth of Pinnipedia as an indication of age. Science 112 (2907):309–311, text-figs. 1–3.

Simpson, G. G. 1932. Fossil Sirenia of Florida and the evolution of the Sirenia. Bull. Amer. Mus. Nat. Hist. 59(8):419–503, text-figs. 1–23.

———. 1945. The principles of classification and a classification of mammals. Bull. Amer. Mus. Nat. Hist. 85:XVI + 350 pp.

Tomes, C. S. 1904. A manual of dental anatomy, human and comparative. 6th. ed. J. & A. Churchill, London, viii + 636 pp.

Trouessart, E.-L. 1898. Catalogus Mammalium tam viventium quam fossilium. Nova editio. Fasciculus V. Sirenia, Cetacea, Edentata, Marsupialia, Allotheria, Monotremata. R. Friedländer & Sohn, Berlin, pp. 999–1264.

———. 1905. Catalogus Mammalium tam viventium quam fossilium. Quinquennale supplementum, Anno 1904. Fasciculus III. Tillodontia, Ungulata et Sirenia. R. Friedländer & Sohn, Berlin, pp. 547–752.

Welles, S. P. 1952. A review of the North American Cretaceous elasmosaurs. Univ. Calif. Publ. Geol. Sci. 29(3):47–144, text-figs. 1–25.

Zittel, K. A. 1893. Handbuch der Palaeontologie. I. Abtheilung Palaeozoologie. IV. Band. Vertebrata (Mammalia). R. Oldenbourg, Munich and Leipzig. XI + 799 pp.

3

QH
1
B4X
NH

o. 27, pp. 305–314 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

MUSEUM OF COMPARATIVE ZOOLOGY
LIBRARY
MAR 3 1976

# A NEW SPECIES OF THE GENUS *ARISTELLIGER* (SAURIA: GEKKONIDAE) FROM THE CAICOS ISLANDS

By Albert Schwartz and Ronald I. Crombie
*Miami-Dade Community College, Miami, Florida 33167, and National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560*

The gekkonid lizard genus *Aristelliger* Cope has its distributional center in the West Indies. The most recent review of the genus (Hecht 1951) recognizes five species: 1) *A. georgeensis* Bocourt in Belize and the islands off the Central American coast from Isla Cozumel to Isla San Andrés; 2) *A. praesignis* Hallowell on Jamaica, the Cayman Islands, the Swan Islands, the Pedro and Morant Cays; 3) *A. cochranae* Grant on Navassa Island, Hispaniola (including Ile de la Gonave), as well as Great Inagua in the southern Bahamas; 4) *A. lar* Cope on Hispaniola, and 5) an unnamed species from the Caicos Islands. In addition to these extant forms, Hecht (1951: 8) named *A. titan*, an extinct giant species from Pleistocene or sub-Recent deposits in Jamaica (where the living form is *A. praesignis*). There has been little subsequent taxonomic work done on the genus and Hecht's arrangement has remained intact (Wermuth 1965) except for Schwartz's (1968: 261, footnote) decision to regard *barbouri* as a species distinct from *A. cochranae*. The undescribed species from the Caicos Islands has remained so.

Cochran (1934: 5) first reported *Aristelliger* (as *A. praesignis*) from Six Hill Cay off South Caicos; the record is based on three specimens collected by Paul Bartsch. Hecht (1951: 24–25) noted the existence of a new species of *Aristelliger* on the Caicos Islands but did not name it. Rabb and

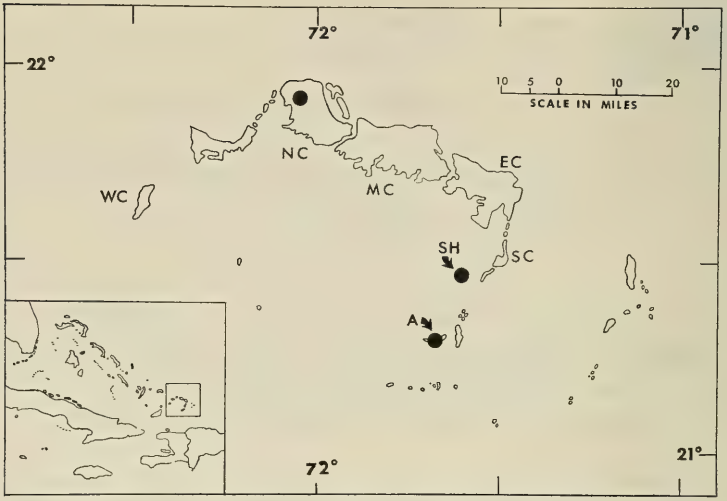



FIG. 1. Map of the Turks and Caicos Bank, showing localities for *A. hechti* (solid circles). WC = West Caicos, NC = North Caicos, MC = Middle Caicos, SC = South Caicos, SH = the Six Hill Cays, A = Little Ambergris Cay. The inset shows the position of the Caicos in the West Indies.

Hayden (1957: 30) visited the Six Hill Cays and secured 12 specimens of *Aristelliger*; they gave a brief synopsis of the vegetation of "these small, forbidding cays." Garth Underwood visited East Six Hill Cay and collected five specimens for the Museum of Comparative Zoology, and David C. Leber secured one specimen there for the senior author. Donald W. Buden collected a series of eight *Aristelliger* on Little Ambergris Cay, a small islet about 15 kilometers south of the Six Hill Cays (Fig. 1). Most recently, George Campbell discovered a population of these geckos on North Caicos but we have only been able to examine one specimen from this collection. Thus, we have available for study a series of 21 *Aristelliger* from the Six Hill Cays, eight from Little Ambergris Cay and one from North Caicos—a total of 30 specimens, far more than were available to Hecht at the time of his study.

We have taken the following measurements (in millimeters) and counts on all specimens: 1) snout-vent length, from mid-point of the rostral scale to anterior border of vent; 2) head

length, from midpoint of rostral to anterior edge of auricular opening; 3) head width, at mid-orbit; 4) fourth finger lamellae, total of both fingers; only functional lamellae were counted, from the first undivided lamella that is wider than the distal lamella, to and including the distal lamella; 5) fourth toe lamellae, total of both toes, counted as in fourth finger; 6) head scales, counted in a more or less straight line along the midline of the snout from the median internasal (or from a line connecting the center of the nostrils) to a line connecting the anterior edge of the preorbital fold; 7) loreals, counted from the enlarged postnasal (but not including it) to the preorbital granules; 8) dorsal scales, the number of paravertebral granules in a standard distance (= from rostral to posterior border of orbit); 9) postmental scales, those scales which lie medially between the enlarged lateral postmental scales; 10) supralabials, total in both upper lips; 11) infralabials, total in both lower lips.

These counts are variously useful in dealing with *Aristelliger*. Counts of head scales, for example, are quite unstable, since many large (and some small) specimens have very irregular scales; reliable counts are difficult and subjective. Loreal counts are slightly more stable, whereas dorsal scale counts are the most subjective. Many large males of all species used in the present study have very irregular dorsal granules, *i.e.* enlarged, trihedral scales scattered among normal-size granules. These individuals would have dorsal counts about half those of "normal" specimens of the same species. In addition, *Aristelliger* have delicate, tissue-like skins which are easily torn; the scales of healed wounds are an additional variable since they too are irregular or abnormal. All these factors render the head and dorsal scale counts very subjective and of doubtful utility. We have, however, used these counts in the following diagnosis since we plan to analyze the variation in a review of the genus *Aristelliger*, now in preparation. Adult size, postmental scales, and lamellae counts are most useful in defining populations.

Sexual maturity and reproductive condition were determined by gonadal inspection. Males of all species except *A. lar* are easily sexed and categorized by the size and state of

the testes. The gonads of sexually mature males are enlarged and granular. For females, all those larger than the smallest gravid female were considered adult; additionally, those females with follicles 3 mm or larger were also regarded as adults.

We agree that the Caicos Island lizards are distinctive from their congeneric neighbors and, in honor of Max K. Hecht, who first recognized these lizards as a new taxon and who laid the foundation for further studies on the genus *Aristelliger*, we propose the following name.

**Aristelliger hechti,** new species

*Holotype*: National Museum of Natural History (USNM) 195844, an adult male, from Little Ambergris Cay, Caicos Islands, one of a series collected by Donald W. Buden, 28 March 1972. Original number Albert Schwartz Field Series (ASFS) V27397.

*Paratypes*: ASFS V27398–404, same data as holotype; USNM 81444–46, Six Hill Cay, off South Caicos, Caicos Islands, P. Bartsch, 3 August 1930; American Museum of Natural History (AMNH) 80119–24, East Six Hill Cay, Caicos Islands, G. B. Rabb and C. L. Giovannoli, 12 February 1953; ASFS 10700, East Six Hill Cay, Caicos Islands, D. C. Leber, 18 January 1961; Museum of Comparative Zoology (MCZ) 54196–200, East Six Hill Cay, Caicos Islands, G. Underwood, 3 July 1955; University of Michigan, Museum of Zoology (UMMZ) 117390 (6 specimens), East Six Hill Cay, Caicos Islands, G. B. Rabb and C. L. Giovannoli, 12 February 1953; Lewis D. Ober Private Collection (LDO) 8-7766, Village Green, near Kew, North Caicos, Caicos Islands, George Campbell, 26 February 1974.

*Definition*: A species of *Aristelliger* characterized by moderate size (males to 90 mm, females to 75 mm snout-vent length), a short and rounded snout, 1 enlarged median postmental scale and a variable dorsal pattern including individuals with a pair of dark scapular ocelli surrounded by pale color and including a pale (whitish) central spot, and/or ocellar pattern reduced or absent, head and body with a scalloped middorsal band or series of fused pale rhombs, or even completely patternless reddish tan, slightly brighter on tail.

*Description of holotype*: An adult male with a snout-vent length of 90 mm, tail broken to a stub; head length 22.8 mm, head width 18.1 mm, fourth toe lamellae 14/14 (total 28), fourth finger lamellae 14/13 (total 27); supralabials 7/6, infralabials 6/5; head scales 21, loreals 18, dorsal scales 40. Coloration and pattern (as preserved) dull gray brown, unpatterned except for a pair of dark gray and obscure scapular ocelli and a dark line from eye onto temporal region above the auricular opening.

*Variation*: The series of *A. hechti* consists of 12 adult males, 14 adult females and four subadults or juveniles (smallest snout-vent length 51 mm; MCZ 54200). Snout-vent lengths of adults are: males 64–90 ($\bar{x} = 80.7$), females 57–75 ($\bar{x} = 66.8$); head length, males 17–23 (20.4), females 15–19 (17.4); head width, males 13–18 (15.3), females 11–15 (12.8). In all specimens: fourth finger lamellae 22–28 (24.6); fourth toe lamellae 24–31 (27.2); supralabials 12–16 (13.7); infralabials 10–14 (11.6); head scales 18–24 (20.0); loreals 16–20 (18.1); dorsals 39–50 (44.0); postmental scales one.

*Color and pattern*: In life ASFS 10700, a large (70 mm S–V) female was "irregular reddish tan, slightly brighter on tail." George B. Rabb furnished the following color notes on his specimens: "Color for most *Aristelliger* is olive, blending and alternating with various browns. A tendency towards a saddle banding on the back, more pronounced in younger ones. In 1613," (UMMZ 117390, an adult female, 63 mm), "for instance, the lighter bands of an orange color, the darker of olive partially margined with dark brown or black. The blotches or bands more evident on tail than back in larger specimens. 1612" (UMMZ, adult female, 62 mm) "very light green in life. 1615" (AMNH 80119, adult female, 60 mm) "with a tail having alternating black and orange, then black and white bands. Yellowish underside of tail and on palms." The dorsa in preserved specimens of both sexes are grayish brown or brownish. In the series of males, some (AMNH 80120, MCZ 54197) are patternless dorsally except for random dark vermiculate markings which probably represent the dark edges of either a dorsal scalloped pale band or a series of fused dorsal rhombs. The holotype resembles these specimens except that it shows remnants of a pair of dark scapular ocelli, although these are not now hollowed centrally. Still another male condition is shown by ASFS V27398 which is the most strongly patterned male; this lizard has a pale middorsal scalloped band composed of six paired pale rhombs, outlined with black or dark gray, the last pair of rhombs on the unregenerated portion of the tail, the most anterior pair on the postscapular region, preceded by a pair of large dark gray ocelli, each hollowed centrally with a pale spot; the middorsal pale band continues onto the neck and head and is there delimited ventrolaterally by a dark canthalpostocular line; on the upper surface of the head, the central pale area is finely stippled with dark gray, especially anteriorly, but the integrity of the pale area is not obliterated by markings. Scapular ocelli are present in some specimens which otherwise show no dorsal pattern (AMNH 80123), and a small male (ASFS V27404) is like the complexly patterned adult male described above, having both dark and hollowed scapular ocelli and a paramedian series of pale dorsal rhombs, although these latter are not outlined with black or gray. Females show the same variation in dorsal pattern as males; some are patternless (AMNH 80122), others have ocellar remnants (ASFS 10700) but no other dorsal pattern remnants,

and still others (ASFS V27403) are as complexly and completely patterned as the male described above. In those specimens with unregenerated tails, the tail is banded with about seven dark bands (the basal one or two of which are dorsally separated by rhomboidal markings) alternating with narrow pale bands, the latter becoming broader nearer the tip, which is black. Regenerated tails are longitudinally streaked with dark gray or are unicolor. In both sexes the venter is paler than the dorsum and the chin and throat are heavily stippled with brown, in rather striking contrast to the much paler belly.

*Comparisons*: Due to the extreme plasticity and variability of the few morphological characters heretofore used to separate the species in the genus *Aristelliger*, a detailed discussion of the relationships of *A. hechti* would be speculative. Since we intend to review the entire genus in the near future, comparisons and relationships are treated minimally. We hope to be able to elaborate on these in the revision.

The genus *Aristelliger* contains two distinctive species groups. *Aristelliger cochranae* and *barbouri* (subgenus *Aristelligella* of Hecht 1951) are small to moderate size lizards (65 mm snout-vent maximum) with a unique arrangement of postmental and digital scales combined with a distinctive dorsal pattern. The lateral postmentals are large (½–¾ as wide as the first infralabial) and in contact on the midline of the mental. Three fingers and two outer toes have a terminal sheathlike scale, called a "friction pad" (see Hecht 1952: 113 for illustration). The pattern develops from a juvenile dorsal "ladder" which fades with maturity but is usually visible.

The other *Aristelliger* have friction pads on only one finger and toe of each foot; the lateral postmentals are separated by one or more median postmentals. The dorsal pattern develops from a series of dorsal rhombs and prominent scapular ocelli, frequently fading to unicolor in adults.

*A. hechti* is a member of the latter group and therefore requires comparison only with *A. lar*, *praesignis* and *georgeensis*. There is a great deal of overlap in the scale counts of these species (Table 1) but the postmental scales are reliable characters which, used in conjunction with other data, will distinguish the species.

*A. lar* is a very large lizard; the smallest mature adults are larger than the largest *hechti*. Over much of its range, *lar* has a single postmental (like *hechti*). However, the *lar* closest geographically to the range of *hechti* (Republica Dominicana: Prov. Monte Cristi; Cayos Siete Hermanos) are smaller lizards (under 100 mm S–V) with two or three postmentals.

*A. georgeensis* is slightly larger than *hechti* and consistently has two or three postmentals. The dorsal pattern is reduced with rare vestiges of scapular ocelli; adults frequently have a dark head with scattered white flecks.

*A. praesignis* is extremely variable but some individuals are similar to *hechti*. We do not yet understand the variability in *praesignis* but

TABLE 1. Measurements (in millimeters) and counts for four species of *Aristelliger*. Lamellae and labial counts are the total of both sides. Data for *A. praesignis* are from Jamaica (type-locality) and for *A. georgeensis* from throughout its range, but principally from Isla San Andrés and Isla Providencia.

| | *hechti* | *lar* | *praesignis* | *georgeensis* |
|---|---|---|---|---|
| N | 30 | 28 | 53 | 38 |
| Largest ♂ | 90 | 132 | 85 | 108 |
| Largest ♀ | 75 | 111 | 65 | 83 |
| Head length | | | | |
| largest ♂ | 22.8 | 33.6 | 21.4 | 27.3 |
| largest ♀ | 18.7 | 26.4 | 15.6 | 21.2 |
| Head width | | | | |
| largest ♂ | 18.1 | 22.2 | 13.3 | 16.9 |
| largest ♀ | 14.6 | 16.7 | 9.5 | 13.1 |
| 4th finger lamellae | 24.6 (22–28) | 26.3 (22–31) | 21.7 (18–26) | 27.3 (24–30) |
| 4th toe lamellae | 27.2 (24–31) | 29.3 (25–33) | 23.8 (20–28) | 29.2 (26–32) |
| Supralabials | 13.7 (12–16) | 13.3 (12–15) | 14.1 (12–16) | 13.1 (12–15) |
| Infralabials | 11.6 (10–14) | 10.8 (10–12) | 11.1 (10–14) | 11.1 (10–12) |
| Head scales | 20.0 (18–24) | 23.5 (20–28) | 19.4 (17–25) | 20.4 (18–24) |
| Loreals | 18.1 (16–20) | 18.8 (16–22) | 16.6 (15–21) | 15.9 (14–18) |
| Dorsals | 44.0 (39–50) | 50.0 (39–60) | 39.4 (32–44) | 41.8 (34–49) |
| Median postmentals | 1 | usually 1, occasionally 2 or 3 | 0–3 | 2 or 3 |

it is generally smaller and less robust than *hechti*, with modally lower lamallae counts and variable postmental arrangement.

*Remarks*: We are unwilling at this time to postulate any zoogeographic sequence of the species included within *Aristelliger*. However, it seems likely that *A. hechti* is most closely related to *A. lar* or *praesignis*. Schwartz (1968) discussed the history of the faunas of the Bahama Islands (including the Turks and Caicos islands) and suggested that these islands south of the Crooked Island Passage harbor a relict fauna, long in residence and well differentiated from their

Cuban or Hispaniolan relatives, often so distinctive as to render their ultimate Greater Antillean relationships obscure. Gorman, Thomas and Atkins (1968) showed that *Anolis scriptus* Garman, a species that occurs in the Turks and Caicos islands and as far north as Samana Cay and Mayaguana Island in the Bahamas south of the Crooked Island Passage, is Puerto Rican in affinities, but well differentiated from its relatives.

These southeastern islands have a fauna which is predominantly Hispaniolan, with some Cuban and Puerto Rican influences. Since none of the primal southeastern fauna is Jamaican in origin (see Schwartz 1968: 265) and the recent southern invaders are also not Jamaican, we should be most inclined to consider *A. hechti* as related to *A. lar* rather than *praesignis*. It seems likely that *A. hechti* is a relict species which reached the Caicos Islands from Hispaniola and has differentiated from perhaps a pre-*lar* stock. The evidence for this relationship is scanty but analysis of recently collected *A. lar* may shed some light on the problem. In addition, we are as yet unsure that there are not other species masquerading under the names *georgeensis*, *lar* and *praesignis*. Considering our present uncertainties regarding the two possible ancestral species of *A. hechti*, it seems futile to speculate further on its relationships and phylogeny.

The islands and situations where *A. hechti* has been taken are seldom visited by collectors. Bartsch collected three *A. hechti* "by turning over rocks" on Six Hill Cay (Cochran 1934: 5). On East Six Hill Cay, David C. Leber secured a single lizard under a rock 6-inches thick, and $3 \times 2$ feet in diameter, with soft ground beneath it, in a stand of *Batis*. Leber also saw a single *Aristelliger* on West Six Hill Cay but did not secure it. The topotypical series was secured by Donald W. Buden in palm trash. Little Ambergris Cay is, according to his field notes, a very low sandy islet about one mi. west of Big Ambergris Cay, strewn with widely scattered *Cocos* and decaying remains of *Cocos*. The general vegetational picture is one of low sparse scrub. The specimen from North Caicos was taken in a crumbling rock fence and others were seen in the ruined buildings of Village Green, a former slave town.

## Acknowledgments

We are grateful to Charles W. Myers, Ernest E. Williams, Ronald A. Nussbaum, and Lewis D. Ober for loans of valuable material from their respective collections. George B. Rabb kindly provided his field notes on the Caicos Islands. Without the assistance of Donald W. Buden and David C. Leber in the field, the number of *A. hechti* available to us would be only 21, and we are accordingly in the debt of these men who have visited the Six Hill and Ambergris Cays on our behalf. George R. Zug and W. Ronald Heyer provided helpful criticism of the manuscript.

## Literature Cited

Cochran, D. M. 1934. Herpetological collections from the West Indies made by Dr. Paul Bartsch under the Walter Rathbone Bacon Scholarship, 1928–1930. Smithsonian Misc. Coll. 92(7): 1–48.

Gorman, G. C., R. Thomas and L. Atkins. 1968. Intra- and interspecific chromosome variation in the lizard *Anolis cristatellus* and its closest relatives. Breviora No. 293:1–13, 7 figs.

Hecht, M. K. 1951. Fossil lizards of the West Indian genus *Aristelliger* (Gekkonidae). American Mus. Novit. No. 1538:1–33, 8 figs.

———. 1952. Natural selection in the lizard genus *Aristelliger*. Evolution 6(1): 112–124, 7 figs.

Rabb, G. B. and E. B. Hayden, Jr. 1957. The Van Voast-American Museum of Natural History Bahama Islands Expedition. Record of the expedition and general features of the islands. American Mus. Novit. No. 1836:1–53, 15 figs.

Schwartz, A. 1968. The geckos (*Sphaerodactylus*) of the southern Bahama Islands. Ann. Carnegie Mus. 39(17):227–271, 5 figs.

Wermuth, H. 1965. Gekkonidae, Pygopodidae, Xantusiidae. *In* Liste der rezenten Amphibien und Reptilien, Das Tierreich Lief. 80. Walter de Gruyter & Co., Berlin and Leipzig. xxii + 246 pp.

3

QH
1
B4X
NH

No. 28, pp. 315–318 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SMITHSONIAN
AUG 27 1975
LIBRARIES

# *ADENOMERA LUTZI* (AMPHIBIA: LEPTODACTYLIDAE), A NEW SPECIES OF FROG FROM GUYANA

By W. Ronald Heyer
*National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560*

Three specimens of a distinctive frog were catalogued as *Leptodactylus hylaedactylus* in the collections of the British Museum (Natural History) (BMNH). Through the courtesy of Alice G. C. Grandison I have recently been able to examine the specimens and partially dissect one of them. The three specimens represent a distinctive new species of the genus *Adenomera*. The three specimens were catalogued in 1872 and 1905. Interestingly, I was not able to locate further specimens in the extensive Guyana collections at the American Museum of Natural History. The genus *Adenomera* has recently been reviewed (Heyer, 1973, 1974); the purpose of this paper is to call attention to the addition of this distinctive new species to the genus.

**Adenomera lutzi,** new species
Figure 1

*Holotype*: BMNH 1905.11.1.17, adult male from Guyana, Chinapoon R., upper Potaro (probably Chenapowu River). Dr. Bovallius, collector.

*Paratypes*: BMNH 1872.10.16.43–44, females, from Guyana, Demerara Falls.

*Diagnosis*: *Adenomera lutzi* differs from all other species in the genus by its large size (male 30 mm, males of other species range from 23.4–27.0 mm maximum SV; females to 34 mm, females of other species range from 24.5–31.0 mm maximum SV), presence of a dark triangular seat patch (absent in other species), and distinct spotting on the posterior face of the thigh (mottled or uniform in other species).

FIG. 1. Dorsal and ventral views of the holotype of *Adenomera lutzi*.

*Description of holotype*: Dorsal outline of snout subelliptical; snout profile rounded-acute; canthus rostralis rounded; loreal slightly concave in cross section; tympanum distinct, greatest diameter ½ eye diameter; vomerine teeth in two transverse series posterior to choanae; vocal slits elongate, paired; no external vocal sac; finger lengths in order of decreasing size III > I > II > IV; first finger just longer than second; large ovoid inner metacarpal tubercle smaller than ovoid outer metacarpal tubercle; dorsal surfaces including eyelids profused with small warty tubercles; short glandular ridge behind each eye; faint indications of mid-dorsal and dorsolateral glandular folds; belly fold distinct; toe tips expanded into small disks, disks not flattened, no circumferential groove; toes lacking fringe; subarticular tubercles pronounced; distinct oval inner metatarsal tubercle larger than distinct rounded outer metatarsal tubercle; tarsal fold not continuous with inner metatarsal tubercle, extending ⅞ length of tarsus; sole of foot with large white tubercles, lower surface of tarsus profused with small white tubercles.

Snout-vent 30.1 mm; head length 11.1 mm; head width 11.2 mm; interorbital distance 2.4 mm; greatest diameter of tympanum 1.7 mm;

eye diameter 3.0 mm; eye-nostril distance 2.8 mm; femur 13.4 mm; tibia 14.6 mm; foot 14.9 mm.

Dorsum tan in preservative with darker brown markings on ridges behind eyes, chevron in shoulder region and two round sacral spots above groin; lips and dorsal limb surfaces barred; circumferential parts of venter mottled, belly lacking melanophores; dark brown triangular seat patch; posterior surface of thigh dark brown with bold white round and elongate spots.

*Variation*: The female paratypes measure 33.6 and 34.1 mm SV. The vomerine teeth are contiguous in one of the specimens. The color patterns are similar to the holotype with the following differences: dark interorbital bars are distinct in the paratypes, indistinct in the holotype; one paratype has dark brown stripes along ⅔ the body length in the dorsolateral fold region; the posterior face of the thighs are not as boldly marked in the paratypes; in the most differently marked paratype, the dark brown seat patch continues as a uniform brown on the thighs with small light spots above and below the uniform brown.

*Etymology*: The species is named in honor of the late Adolfo Lutz, a Brazilian pioneer in herpetology. Dr. Lutz was the first worker with field experience to call attention to the distinctiveness of the frogs comprising the genus *Adenomera*.

## Anatomical Summary

One paratype, BMNH 1872.10.16.43, was partially dissected to determine certain muscle and skeletal character states. The other paratype was X-rayed to determine the shape of the terminal phalanges. Origin of depressor mandibulae muscle mostly from dorsal fascia, with some fibers originating from the squamosal bone and the annulus tympanicus. Adductor mandibulae posterior subexternus present, adductor mandibulae externus superficialis absent. Geniohyoideus medialis muscle continuous medially (Heyer, 1974, Fig. 2, O). Geniohyoideus lateralis muscle lacking attachment or slip to hyale. Anterior petrohyoideus muscle inserting on ventral surface of alary process of hyoid (Heyer, 1974, Fig. 1, G). Sternohyoideus muscle insertion on ventral body of hyoid (Heyer, 1974, Fig. 1, I). Omohyoideus muscle insertion on ventral surface of hyoid plate (Heyer, 1974, Fig. 4, 2). Iliacus externus muscle extending full length of iliac bone. Tensor fasciae latae muscle inserting posterior to iliacus externus muscle on iliac bone. Exterior head of semitendinosus muscle absent. Sartorius muscle broad, covering adductor longus muscle. Accessory head of adductor magnus muscle ending proximally in a tendon. Adductor longus muscle well developed, inserting on knee. Anterior process of hyale absent. Alary process of hyoid broad and winglike (Heyer, 1974, Fig. 1, G). Omosternum slightly expanded anteriorly. Mesosternum a bony style. Xiphisternum cartilaginous, entire, single. Terminal phalanges T-shaped.

All known myological and osteological character states of the new species agree with the previous definition of the genus (Heyer, 1974). The new species extends the known snout-vent length from 27.0 mm to 30.1 mm in males, and 31.0 to 34.1 mm in females.

## Discussion

The relationships among the species of the genus *Adenomera* remain obscure. There are few morphological specializations shared by two or more species on which to base an analysis of relationships. The most suggestive characters are in the hyoid complex. The new species and *A. martinezi* share the states of the anterior petrohyoideus inserting on the ventral surface of the hyoid apparatus and a broad winglike alary process of the hyoid. Previously, I considered these as derived states (Heyer, 1974). If these states are derived, then *A. lutzi* and *martinezi* are the most closely related species in the genus *Adenomera*. My subjective impression is the opposite, however. The four species *A. andreae, bokermanni, hylaedactyla,* and *marmorata* form a tight cluster and are distinguished from each other by subtle morphological differences. On the other hand, *A. lutzi* and *martinezi* are the most distinctive species in the genus and very distinctive from each other. In the case of *Adenomera*, it appears that a broad winglike alary process and ventral insertion of the anterior petrohyoideus muscle are primitive states. Resolution of the intrageneric relationships may well require biochemical and/or more karyotypic information.

## Acknowledgments

Alice G. C. Grandison and A. F. Stimson, British Museum (Natural History) allowed me to examine the specimens in their care and provided information on the geographic origin of the specimens.

George R. Zug, Smithsonian Institution, read the manuscript.

The Smithsonian Research Foundation supported the research for this paper.

## Literature Cited

Heyer, W. R. 1973. Systematics of the Marmoratus group of the frog genus *Leptodactylus* (Amphibia, Leptodactylidae). Contrib. Sci., Los Angeles County Mus. Natur. Hist. 251:1–50.

———. 1974. Relationships of the *Marmoratus* species group (Amphibia, Leptodactylidae) within the Subfamily Leptodactylinae. Contrib. Sci., Los Angeles County Mus. Natur. Hist. 253:1–46.

, No. 29, pp. 319–330 15 August 1975

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES

# *LABIDOCHROMIS TEXTILIS*, A NEW CICHLID FISH (TELEOSTEI: CICHLIDAE) FROM LAKE MALAWI

By Michael K. Oliver
*Department of Ichthyology, American Museum of Natural History, New York, N.Y. 10024*

An aquarist (Johnson, 1974a) recently published brief descriptions of two new species of *Labidochromis*, a genus of cichlid fishes endemic to Lake Malawi, Africa. He based one of them, *L. joanjohnsonae*, on a holotype and paratype belonging to two species that differ strikingly from each other in coloration and oral dentition. Although he gave conflicting statements both of standard length and total length of the paratype in different paragraphs, Johnson (1974a: 15) clearly designated the smaller of the two specimens as the holotype, and since they differ in standard length by nearly 10 mm there is no doubt as to which this is. The number of dorsal fin spines (sixteen in the holotype, seventeen in the paratype) corroborates his designation. It might be noted, however, that Johnson's counts of segmented dorsal rays are inaccurate for both specimens.

I have examined the types of all species described by Johnson (1974a and 1974b) and found that the holotype of *L. joanjohnsonae* Johnson is a specimen of *L. fryeri* Oliver *in* Davies (1973); *L. joanjohnsonae* is therefore a junior synonym of that species. The manuscript name *Labidochromis fryeri* and a diagnosis of this taxon were unfortunately published in an aquarium magazine in a letter from T. E. (Peter) Davies, who specifically (and correctly) attributed to me the name, the diagnosis, and my intention eventually to publish them. Regrettably, by Articles 11 and 13 (a) (i) of the International

Code of Zoological Nomenclature the name *Labidochromis fryeri* is clearly available, and by Article 50 I am its author. I am preparing a full description of that species, with a designation of type-specimens, for publication elsewhere.

The paratype of *L. joanjohnsonae*, figured by Johnson (1974a: 16, fig. 2) but wrongly captioned the holotype, is recognizable in his color photograph because of its proportions and fin markings. It represents an undescribed species of *Labidochromis* discovered by Mr. Richard Furzer on the Mozambique shore of Lake Malawi and first exported by him to the American aquarium trade in January 1973. The same species has since been collected at Likoma Island by T. E. Davies and party. I was already preparing a description of this *Labidochromis* before Johnson became interested in it. Since Johnson (1974a: 14) expressed a wish to avoid "even greater duplication of Mr. Oliver's forthcoming work on this genus," I do not hesitate to describe it at this time. It is hoped that this comely species will not continue to circulate in the aquarium trade under the name *L. joanjohnsonae*, junior synonym of the quite distinct species *L. fryeri*.

Counts and measurements herein employed follow Greenwood (1973), except that vertebral counts include the fused first preural and ural centra supporting the parhypural and hypurals; my counts of caudal and total vertebrae are therefore one greater than his. Pectoral rays, scales, gill rakers, and teeth were counted on both sides of each fish. Standard deviation (SD) and standard error (SE) were calculated for the principal morphometric ratios.

**Labidochromis textilis,** new species

Brocade Cichlid

Figures 1–5

*Labidochromis joanjohnsonae* Johnson, 1974a: 15, in part, paratype only, by original designation, p. 15; incorrectly designated as holotype in fig. 2 (Likoma Island).

*Labidochromis* sp. Axelrod, 1974: 224, in part, lower photograph only (Likoma Island). Fish in upper photograph possibly *L. caeruleus* Fryer, 1956.

*Labidochromis caeruleus "likomae"* Scheuermann, 1974: 441, trade name only, in part, "weibchen" only, lower photograph, non *caeruleus*

Fryer, 1956 (Likoma Island). Fish in upper photograph possibly *L. caeruleus.*

*Labidochromis spec. nov.* (*marineatus*) Neergaard, 1974: 74–75 and photograph p. 75, trade name only (Likoma Island).

*Notes on synonymy*: The collectors who export aquarium fishes from Lake Malawi commonly coin pseudo-scientific trade names for species they cannot identify. This practice is strongly to be discouraged because it promotes nomenclatural instability and confusion when, as frequently happens, such names are published in the aquarium literature. An example is the name *Labidochromis caeruleus "likomae."* Scheuermann (1974) did not intend to propose this as a formal scientific name; as the following evidence shows he: (1) attributed the name to an unspecified dealer of aquarium fishes; (2) always included it between quotation marks whereas he used no quotation marks for the established species *Labidochromis caeruleus* and its implied subspecies *L. c. caeruleus*; (3) did not write in the style of an original description; (4) provided no formal diagnosis; (5) designated no type-material; and (6) did not clearly assign a rank to the taxon, saying only that its treatment as a subspecies is "an assumption to which I also incline" (eine Annahme, zu der auch ich neige) but later in the same sentence that it is one of several "phenotypes" (Erscheinungsformen) of *L. caeruleus.* These facts indicate that *L. c. "likomae"* is merely a trade name, without standing in formal zoological nomenclature. A second trade name mentioned by Scheuermann (1974), *L. c. "nkatae,"* is apparently not a synonym of *L. textilis*; rather, it is a nomen nudum since it was published without any diagnosis or indication and from the text it cannot be identified with any species.

Neergaard (1974) also employed several names that are clearly not available. For the present species he used *Labidochromis spec. nov.* as the scientific name and the parenthetical *marineatus* as the trade name, not as a formal specific epithet (Neergaard, 1974: 26–27 and personal commun.); moreover the term *marineatus* is not associated, in the meaning of the Code, with a generic name because of the intervening words.

Collectors of aquarium fishes would serve the best interest of aquarist and ichthyologist alike if they proposed a simple common name such as "Brocade cichlid" for each unidentified species or form, instead of a troublesome and deceptive pseudo-scientific term.

*Holotype*: British Museum (Natural History) (BMNH) Reg. No. 1975.5.27: 9, a mature male 76.5 mm standard length (SL), an aquarium specimen exported from Lake Malawi and probably collected at Likoma Island by T. E. Davies and party; donated by Mrs. Virginia Egolf.

*Paratypes*: Aquarium specimens exported from Lake Malawi by T. E. Davies and R. E. Furzer: BMNH Reg. Nos. 1975.5.27: 10–12 (3 specimens, 43.0, 45.5, 53.0 mm SL); 1975.5.27: 14–15 (2, 47.0–50.0 mm); 1975.5.27: 13 (1, 53.5 mm); 1975.5.27: 16–17 (2, 33.0–37.0 mm).

TABLE 1. Principal morphometric ratios of *Labidochromis textilis*. % = percent of head length, † = percent of standard length, * = paratype of *Labidochromis joanjohnsonae*

| Character | Mean | SD | SE | Paratypes | | | | | | | | | | | * | Holo-type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard length (mm) | | | | 33.0 | 37.0 | 43.0 | 45.5 | 47.0 | 49.5 | 50.0 | 50.5 | 53.0 | 53.5 | 66.0 | 68.0 | 76.5 |
| Body depth (†) | 31.7 | 0.87 | 0.25 | 32.7 | 31.4 | 30.2 | 30.8 | 31.1 | 31.9 | 32.0 | 30.5 | 32.1 | 32.0 | 32.6 | 33.1 | 31.6 |
| Head length (†) | 32.2 | 1.54 | 0.44 | 31.2 | 29.7 | 34.9 | 32.5 | 30.4 | 32.7 | 30.6 | 33.1 | 33.4 | 33.1 | 34.1 | 31.5 | 31.4 |
| Head breadth (%) | 46.7 | 2.80 | 0.81 | 50.5 | 50.9 | 42.7 | 45.9 | 49.0 | 45.1 | 51.0 | 46.1 | 44.1 | 44.1 | 44.4 | 46.7 | 46.7 |
| Preorbital depth (%) | 19.2 | 2.15 | 0.62 | 14.6 | 16.4 | 18.7 | 18.9 | 18.2 | 19.1 | 19.6 | 20.4 | 19.8 | 19.2 | 20.4 | 20.1 | 23.8 |
| Interorbital width (%) | 20.7 | 1.93 | 0.56 | 18.4 | 20.9 | 18.0 | 18.9 | 23.1 | 19.8 | 24.2 | 21.0 | 19.2 | 19.8 | 21.3 | 22.0 | 22.9 |
| Snout length (%) | 31.3 | 2.90 | 0.84 | 25.7 | 29.1 | 32.0 | 29.1 | 30.8 | 32.1 | 29.4 | 32.3 | 31.6 | 29.9 | 34.2 | 33.6 | 37.5 |
| Orbit length (%) | 30.9 | 3.40 | 0.98 | 36.9 | 34.5 | 32.0 | 31.8 | 32.2 | 30.9 | 33.3 | 31.1 | 31.1 | 29.9 | 26.7 | 25.7 | 25.0 |
| Cheek depth (%) | 20.0 | 2.57 | 0.74 | 17.5 | 18.2 | 17.3 | 20.9 | 21.0 | 17.3 | 22.2 | 19.8 | 21.5 | 17.5 | 20.0 | 20.6 | 26.3 |
| Postorbital head length (%) | 43.5 | 2.17 | 0.63 | 45.6 | 47.3 | 40.0 | 42.6 | 45.5 | 41.4 | 46.4 | 43.1 | 42.4 | 41.8 | 42.7 | 44.4 | 42.1 |
| Upper jaw length (%) | 26.7 | 1.12 | 0.32 | 26.2 | 26.4 | 26.7 | 26.4 | 25.9 | 24.7 | 27.5 | 28.1 | 27.1 | 25.4 | 27.6 | 26.2 | 28.8 |
| Premaxillary pedicels (%) | 27.4 | 1.44 | 0.41 | 24.3 | 25.5 | 26.7 | 28.4 | 28.0 | 27.2 | 28.1 | 29.9 | 28.8 | 27.1 | 27.1 | 27.1 | 28.3 |
| Lower jaw length (%) | 33.6 | 1.96 | 0.57 | 34.0 | 33.6 | 33.3 | 33.8 | 30.1 | 34.0 | 30.7 | 31.1 | 33.9 | 35.6 | 35.6 | 34.6 | 36.7 |
| Predorsal length (†) | 33.3 | 1.91 | 0.55 | 33.0 | 30.5 | 36.5 | 35.4 | 30.4 | 33.3 | 32.2 | 32.9 | 35.3 | 33.1 | 35.6 | 31.9 | 33.3 |
| Dorsal fin base length (†) | 57.2 | 2.66 | 0.77 | 62.1 | 59.7 | 50.9 | 56.9 | 57.9 | 56.4 | 57.4 | 55.4 | 56.0 | 56.1 | 57.6 | 59.9 | 57.8 |
| Caudal peduncle length (†) | 15.1 | 0.95 | 0.27 | 17.0 | 15.1 | 14.4 | 15.8 | 15.7 | 13.7 | 16.2 | 14.1 | 15.3 | 15.1 | 13.8 | 15.0 | 15.4 |

American Museum of Natural History (AMNH) 32413 (2, 49.5–66.0 mm); AMNH 32414 (1, 50.5 mm); AMNH 33465 (1, 68.0 mm, paratype of *L. joanjohnsonae*).

*Etymology*: The trivial name, from the Latin for woven, refers to the life coloration which suggests brocade cloth.

*Diagnosis*: *Labidochromis textilis* differs from all other species of *Labidochromis* in having about 12 alternating horizontal stripes of orange and pale blue or blue-green on side of body in life, and distinct, oval orange spots (brown in preserved fish) on dorsal and caudal fins of adults.

*Description*: Based on holotype (Fig. 1) and twelve paratypes, 33.0–76.5 mm SL. Principal morphometric ratios given in Table 1.

Dorsal profile of head usually straight from tip of snout to over rear of orbit in mature fish; snout slightly concave in large specimens. Dorsal margin of orbit lying below dorsal profile of head when fish viewed laterally; premaxillary pedicels not entering profile. Snout 0.9–1.25 times broader than long. Angle of premaxillary pedicels 30°–40° to horizontal; frontal angle 25°–40°. Cephalic lateral line pores and canals not hypertrophied.

Posterior tip of maxilla usually reaching level of anterior orbital or ocular margin. Jaws pointed or narrowly rounded anteriorly when fish viewed from above or below. Lower jaw projecting slightly, 1.1–1.4 times longer than broad, its angle 30°–40°.

Caudal peduncle 1.02–1.30 (mean, M = 1.17) times longer than deep.

Fins: Dorsal with 25 (in 8 specimens), 26 (4), or 27 (1) elements, comprising 16 (2), 17 (10), or 18 (1) spines and 8 (6) or 9 (7) segmented rays; last spine 13.6–16.2 (M = 15.0) % of SL. Anal with 10(9) or 11 (4) elements, comprising 3 spines and 7 (9) or 8 (4) segmented rays; last spine 14.2–16.7 (M = 16.0) % of SL. Pectorals 20.2–25.3 (M = 23.4) % of SL; with 13–15 (mode 14) rays, comprising 2 upper unbranched, 9–11 (mode 10) branched, and 1–3 (mode 2) lower unbranched rays. Caudal slightly rounded to emarginate, lobes rounded and subequal; scaled on proximal ¼–⅔ (medially) or ⅖–⅘ (dorsally and ventrally), extent of scale coverage positively correlated with standard length. Pelvics 23.5–29.7 (M = 26.0) % of SL, longest in mature males, first ray slightly produced in both sexes; spine 13.5–16.8 (M = 15.0) % of SL.

Scales: Ctenoid. Lateral line with 30–32 (mode 31) scales, upper part with 20–24 (mode 24), lower with 8–12 (mode 10). (50.0 mm paratype abnormal in lacking lower part of right lateral line; scales in that area appear normal and unregenerated, completely lacking canals and pores. Upper part of right lateral line comprising 20 scales; on left side upper part with 22, lower 10, total 32.) Cheek with 4–6 (mode 5) rows. About 5–8 scales between dorsal fin origin and upper part of lateral line. Seven to 9 scales between pectoral and pelvic fin

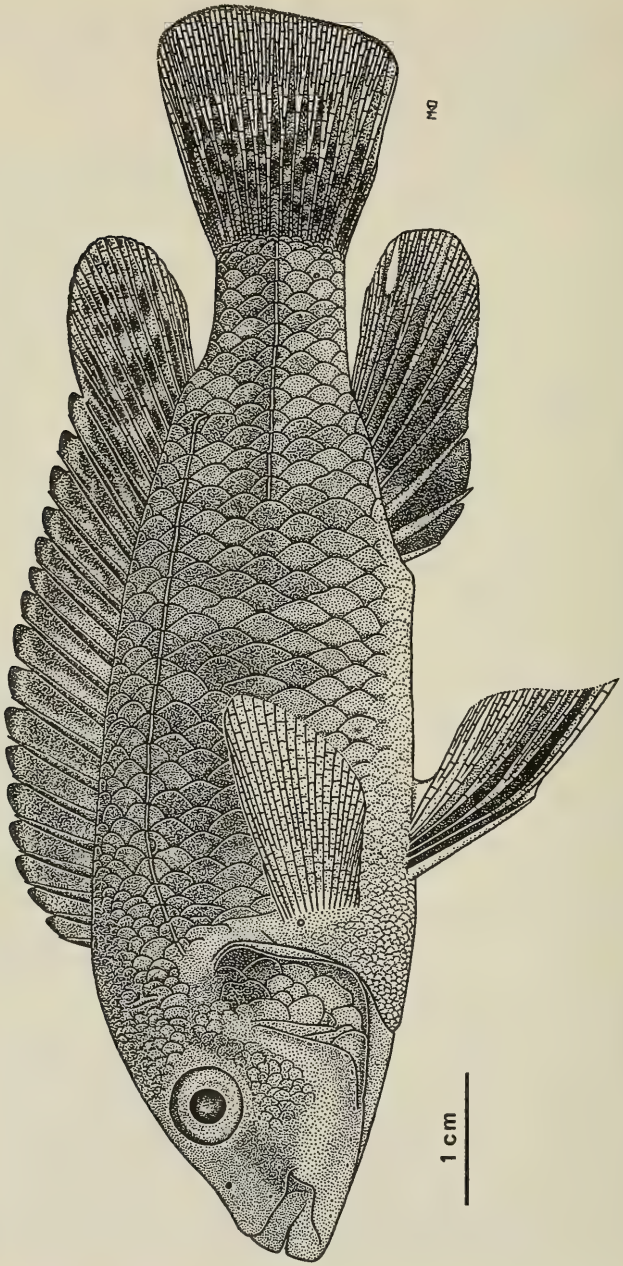



FIG. 1. *Labidochromis textilis*. Holotype.

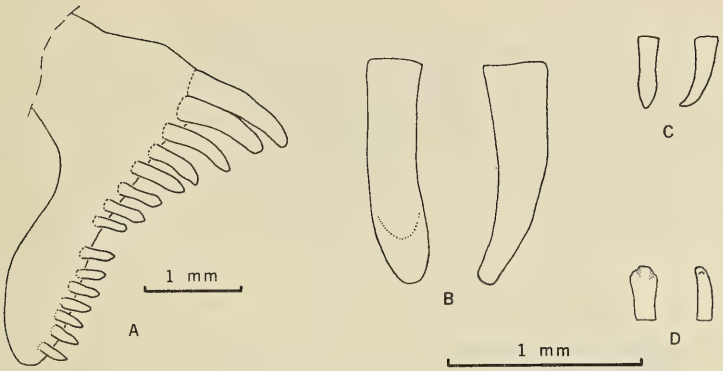



FIG. 2. Oral dentition of *Labidochromis textilis*, drawn from 53.0-mm paratype. (A) Right premaxilla, viewed from a lateral and slightly dorsal position. (B) Anteriormost tooth of right premaxilla. Lingual view at left, lateral view at right. (C) Fourth tooth from posterior tip of right premaxilla. Lingual view at left, lateral view at right. (D) Tooth of outermost inner row of right dentary, anterior in position. Lingual view at left, lateral view at right.

bases; small thoracic scales grade gradually into larger scales of belly. Sixteen scales around caudal peduncle.

Gill rakers: 2–4 (mode 3) on epibranchial + 1 + 8–10 (usually 9 or 10) on ceratobranchial of outer arch. Upper ceratobranchial rakers simple, rather short; lower 2 or 3 rudimentary.

Teeth (*Fig. 2*): Outer row of upper jaw with a total of 27–33 (M = 29.4) teeth in all but two smallest specimens (33 and 37 mm SL), both with 19. About 4 anterior teeth on each side slightly procumbent and markedly longer and coarser than lateral and posterior teeth, into which they grade in size. All teeth unicuspid (a single exceptional unequally bicuspid tooth present laterally in 50.0 mm paratype), crowns acute, isoscelene in outline, compressed in curved plane of premaxilla, and somewhat incurved. Teeth of outer row of lower jaw similar in form to those of upper jaw, but anterior ones strongly procumbent. Inner teeth of each jaw miniatures of outer teeth, generally unicuspid but sometimes weakly tricuspid. Crowns compressed in curved plane of jaws, and incurved. Anterior inner teeth markedly larger than adjacent lateral teeth of inner rows and grading into them in size; 1 or 2 inner rows in each jaw, and sometimes a short third row anteriorly in large specimens.

Lower pharyngeal bone (Fig. 3) triangular in outline, 1.19–1.46 (M = 1.28) times broader than long, its length 20.0–24.0 (M = 22.0) % of head length, its breadth 51.9–67.2 (M = 60.4) % of head breadth. Joint uniting two halves straight, not sinuous; blade shallow, not angled

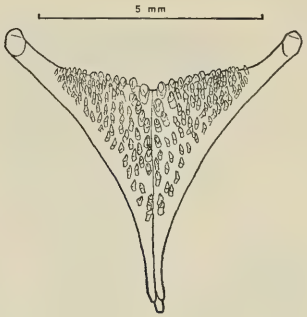



FIG. 3. *Labidochromis textilis*. Lower pharyngeal bone of holotype, in occlusal view.

relative to plane of dentigerous surface. Dentigerous area 1.4–1.6 (rarely almost 1.8) times broader than long. Teeth rather small but not densely crowded; crowns compressed, bicuspid. About 4 postero-median teeth slightly or markedly coarser than adjacent anterior and lateral teeth but crowns always compressed; 22–32 (M = 29.0) teeth in posterior row, 7–11 in an antero-posterior row, and 5–8 in an oblique row.

Vertebral counts in 13 specimens radiographed: 29 (in 3), 30 (9), or 31 (1), comprising 13 (4) or 14 (9) abdominal and 15 (1), 16 (9), or 17 (3) caudal centra. Modal combination 14 + 16 (in 7).

Caudal skeleton: Patterns of hypural fusion include no fusion (in 6), 1 and 2 fused (2), 3 and 4 fused (2), and 1 fused with 2 as well as 3 fused with 4 (3). No correlation between length of fish and degree of fusion.

*Coloration in life*: Live fish of both sexes, adult but sexually quiescent, light blue to blue-green on the head and body, becoming white on ventral surfaces. Distinctive pattern of about 6 to 9 irregular, horizontal orange stripes on the flanks superimposed on this ground color (Fig. 4). No apparent correlation between number of stripes and length of fish. Head with irregularly shaped orange stripes and blotches, among which invariably occurs an oblique stripe that extends from upper end of operculum upwards and forwards to nape. Blackish markings on head, generally indistinct, include a lachrymal stripe, an opercular spot, and 1 horizontal stripe crossing interorbital region and another crossing snout. About 8 dusky vertical bars on flanks below dorsal fin base, rarely apparent except as a "fright pattern." Dorsal fin is light iridescent blue, frequently with a narrow, broken orange stripe basally; lappets are orange distally, bluish white proximally. A broad submarginal band in spinous portion sometimes dark brown and composed of vertical marks between spines, forming an almost continuous horizontal stripe,

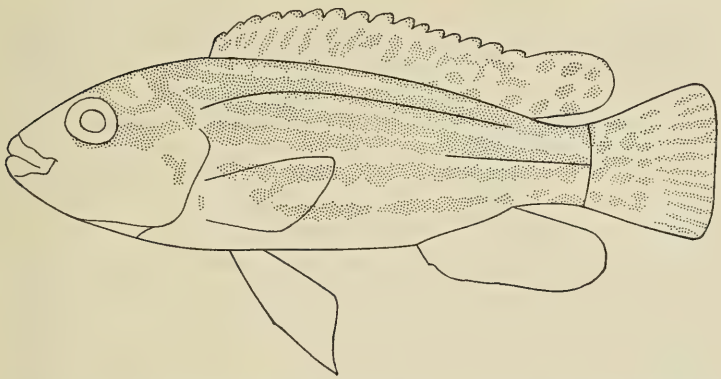


FIG. 4. Orange coloration (stippled) of live specimens of *Labidochromis textilis*. The pattern shows much individual and ontogenetic variation, particularly on fins and head. Semidiagrammatic.

or sometimes consisting of isolated oval orange spots between spines. (It is possible that there is an ontogenetic development from the former condition to the latter, or that the two conditions represent sexual dimorphism, but neither possibility can be verified with the limited material available.) Soft portion of dorsal fin with 2 to 4 rows of oval orange spots, relatively smaller and more numerous in larger fish; fin sometimes with a narrow orange to brick-red margin. Caudal iridescent pale blue with bluish white dorsal and ventral edges and sometimes an orange to brick-red posterior margin. Proximal portion of fin with several vertical rows of orange spots; distal half to ¾ sometimes spotted, or rays orange posteriorly, producing horizontal orange stripes alternating with blue of membrane. Anal fin whitish to iridescent pale blue, sometimes with a fairly distinct, dusky submarginal stripe on spinous portion. The anal ocelli numbering 1 to 5 and deep yellow. Pelvic fins dirty white to dusky, darkest anteriorly except for bluish white leading edge.

Coloration of breeding individuals unknown.

*Preserved coloration*: Both sexes with head and body brown, darker dorsally. Orange markings of body and head usually lost, but a few specimens retaining horizontal stripes of flanks in dark brown contrasted to paler ground color. Orange markings of dorsal and caudal fins always retained, becoming dark brown. About 8 dark vertical bars on flanks usually evident.

*Ecology*: Nothing is known of the ecology of *L. textilis* except that it inhabits shallow inshore water.

*Breeding*: Scheuermann (1974) reported that *L. textilis* is a female mouth brooder (see below under Relationships, however, uncertain as

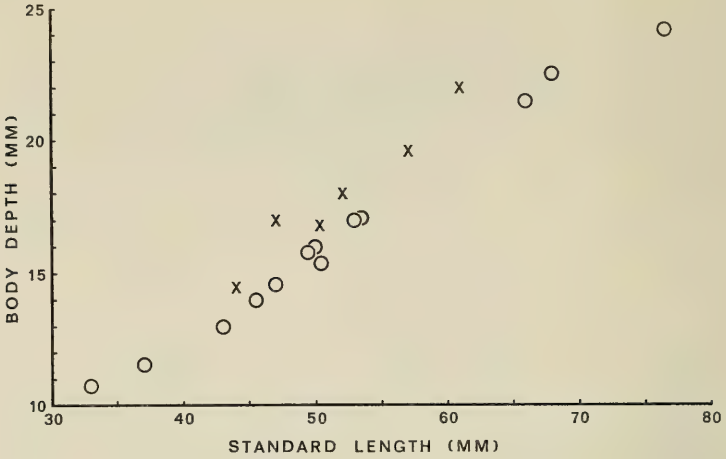



FIG. 5. Relationship of body depth to standard length in *Labidochromis textilis* (○) and *L. caeruleus* (×). Data for *L. caeruleus* replotted from Fryer (1956).

to the identity of the male parent of the broods he observed). *L. textilis* matures at a small size. The smallest adult male is the 53.0 mm SL paratype, ripe or nearly so. The smallest mature female is the 43.0 mm SL paratype, a ripe individual in which the left ovary is undeveloped and the right ovary contains seven ripe ova, all of about the same size and bright orange, the largest measuring 4.0 × 2.8 × 1.8 mm. These ova so distend the ovary that it nearly fills the abdominal cavity.

*Relationships*: An analysis of the phylogenetic relationships of *L. textilis* must await the description or redescription of all other known species of *Labidochromis*, a project which I have undertaken as part of a larger study of the systematics of Lake Malawi *Haplochromis* and related species. For the present it is necessary only to examine the statement of Scheuermann (1974) that *L. textilis* represents the female of a color form or subspecies of *L. caeruleus* Fryer of which the male is blue and lacks orange markings. Axelrod (1974: 224) also believed that a similar blue fish and the orange striped fish represent male and female of a single *Labidochromis* species, although he did not identify the species by name. This suggestion is refuted by the finding of both male and female fish among the type-series of *L. textilis*, all of which had orange stripes in life. Scheuermann claimed that one of his orange striped females spawned in his aquarium with an unstriped blue male; however, he stated (1974: 440) that he did not observe the spawning itself. It is therefore possible (a) that the male parent was also one of his orange striped fish (i.e. was also *L. textilis*), or (b) that only

females of *L. textilis* were present and that one of them spawned with a blue fish, which, to judge from Scheuermann's photograph, may possibly be the true *L. caeruleus*. Interspecific and even intergeneric hybrids of Lake Malawi cichlids have been produced in aquaria when a fish is not given a conspecific mate (D. H. Eccles, personal commun.). It is not possible to decide between these alternatives since Scheuermann's specimens are not available for examination.

In any case, *L. textilis* does not appear to be a color form of *L. caeruleus*. That species resembles *L. textilis* meristically but differs from it in several morphometric ratios. *L. caeruleus* has a deeper body (Fig. 5), a longer head (34.25–36.0 % of SL, *cf* 29.7–34.9, M = 32.2 % in *L. textilis*), a longer snout (34.0–38.9 % of head length, *cf* 25.7–32.3 % in *L. textilis* excluding the three largest types, all of which are of greater total length than any of Fryer's *L. caeruleus* specimens), and a longer snout relative to postorbital head length (snout "a trifle shorter than post, orbital [sic] part of head" [Fryer, 1956: 88], *cf* snout = 0.56–0.80, M = 0.70 times postorbital head in *L. textilis*). Such differences are conceivably ascribable to geographic variation, but I have not encountered comparable geographic variation in morphometrics among other species of Malawi cichlids.

## Acknowledgments

Drs. C. Lavett Smith and Donn E. Rosen provided valuable commentary on the tangled nomenclatural problems encountered in this study. Mrs. Virginia Eglof, Mr. Robert C. Brooks, and Mr. Paul V. Loiselle supplied most of the type-specimens of *L. textilis*. Mr. Brooks also provided color transparencies of living specimens, as did Mr. Rick Johnson. Mr. Søren Neergaard furnished a copy of his book and comments on the names therein employed. Finally, Dr. James W. Atz gave incisive criticism of the manuscript and much additional help. To all of these generous persons I am most grateful.

## Literature Cited

Axelrod, H. R. 1974. African Cichlids of Lakes Malawi and Tanganyika. Second ed. T.F.H. Publications, Inc. Ltd., Hong Kong. 256 pp.

Davies, P. 1973. [Letter] p. 65. *In* H. R. Axelrod, African cichlids of Lakes Malawi and Tanganyika. Trop. Fish Hobbyist 22(3): 42–43, 45–48, 52–55, 57–59, 61–65.

Fryer, G. 1956. New species of cichlid fishes from Lake Nyasa. Rev. Zool. Bot. Afr. 53(1–2):81–91.

Greenwood, P. H. 1973. A revision of the *Haplochromis* and related species (Pisces: Cichlidae) from Lake George, Uganda. Bull. Brit. Mus. nat. Hist. (Zool.) 25(5):139–242.

Johnson, D. S. 1974a. New cichlids from Lake Malawi. Today's Aquarist [Norwalk, Connecticut] 1(1):12, 14–17, 4 figs.

———. 1974b. Three new cichlids from Lake Malawi. Today's Aquarist [Norwalk, Connecticut] 1(3):38–42.

NEERGAARD, S. 1974. Nyasa-Cichlider. J. Fr. Clausens Forlag, Copenhagen. 88 pp.

SCHEUERMANN, H. 1974. Beobachtungen bei Labidochromis caeruleus "likomae." Aquarium Aqua Terra [Wuppertal] 8(64):439–441.

3

QH
1
B4X
NH

No. 30, pp. 331–344 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# A NEW GENUS AND SPECIES OF CHARACID FISH FROM THE BAYANO RIVER BASIN, PANAMÁ (PISCES: CYPRINIFORMES)

LIBRARIES FEB 3 1976

By William L. Fink
*Division of Fishes*
*National Museum of Natural History*
*Washington, D.C., 20560*
*and*
*Department of Biology*
*George Washington University*
*Washington, D.C., 20006*

As a part of their pioneering work on the fish fauna of Panamá, Meek and Hildebrand (1916) described the fauna of the lower Bayano river. At that time, travel to the upper tributaries of the river was very difficult and was not attempted by them; however, recent new roads have opened previously poorly-collected areas of the region to reveal a unique fauna in the upper Bayano tributaries. Dr. J. D. McPhail, University of British Columbia, is preparing a study on the ecology and distribution of the fishes of the area and has made specimens of an unusual characid available for the following description.

I wish to thank Dr. Donald L. Kramer of the Smithsonian Tropical Research Institute (STRI) and Dr. McPhail for specimens of the new species, along with information regarding its distribution and ecology. Dr. Kramer also made valuable comments on the manuscript. Richard Goodyear of the Universidad de Panamá has aided in acquisition of specimens and supplied valuable information on the Bayano river. Dr. Stanley H. Weitzman kindly read the manuscript and has participated in numerous discussions on characids.

Methods are those used in Fink and Weitzman (1974).

TABLE 1. Morphometrics of *E. bayano* in percent of standard length

| Characters | males, range | females, range | male, holotype |
|---|---|---|---|
| Standard length | 43.2–52.1 | 40.4–55.9 | 51.7 |
| Greatest depth | 27.7–33.7 | 31.3–34.7 | 31.7 |
| Snout–dorsal fin origin | 48.9–53.0 | 50.2–54.0 | 49.5 |
| Snout–pectoral fin origin | 24.7–27.1 | 25.0–27.8 | 24.7 |
| Snout–pelvic fin origin | 40.6–45.3 | 42.0–46.4 | 42.5 |
| Snout–anal fin origin | 57.6–61.7 | 60.8–64.0 | 58.0 |
| Caudal peduncle depth | 12.3–15.8 | 11.6–13.8 | 14.7 |
| Caudal peduncle length | 11.9–14.7 | 11.6–13.4 | 14.7 |
| Pectoral fin length | 22.2–24.3 | 21.1–23.5 | 23.0 |
| Pelvic fin length | 16.2–18.2 | 14.8–16.6 | 18.0 |
| Dorsal fin length | 22.9–25.2 | 23.1–26.7 | 24.0 |
| Head length | 24.2–27.6 | 25.9–27.8 | 25.3 |
| Eye diameter | 9.1–10.3 | 9.5–11.1 | 9.1 |
| Snout length | 6.1– 7.6 | 6.5– 8.1 | 6.9 |
| Interorbital width | 7.5– 8.2 | 7.7– 8.8 | 7.9 |
| Upper jaw length | 10.4–12.4 | 10.9–12.9 | 10.8 |
| Eye–dorsal fin origin | 35.0–38.9 | 36.4–38.3 | 35.4 |
| Dorsal fin origin–caudal fin origin | 51.4–55.0 | 50.6–54.1 | 52.8 |

Morphometric characters are given as percent of standard length (SL). In the description, range is given for morphometric characters; range for males and females separated by sex and the morphometric characters of the holotype are given in Table 1. Meristic characters are given in the text, holotype first, followed in parentheses by the range. Paratypes have been deposited in the National Museum of Natural History, Washington, D.C. (USNM), British Museum (Natural History) (BMNH), Academy of Natural Sciences, Philadelphia (ANSP), California Academy of Sciences, San Francisco (CAS), and Zoological Museum of the University of Amsterdam (ZMA).

**Eretmobrycon**, new genus

*Type-species*: *Eretmobrycon bayano*, new species.

*Diagnosis*: Pelvic fin with i,8 rays. Caudal fin of mature males asymmetrical, lower lobe much enlarged. Ventral rays of lower caudal fin lobe thickened and expanded dorsoventrally (Fig. 1). Caudal fin

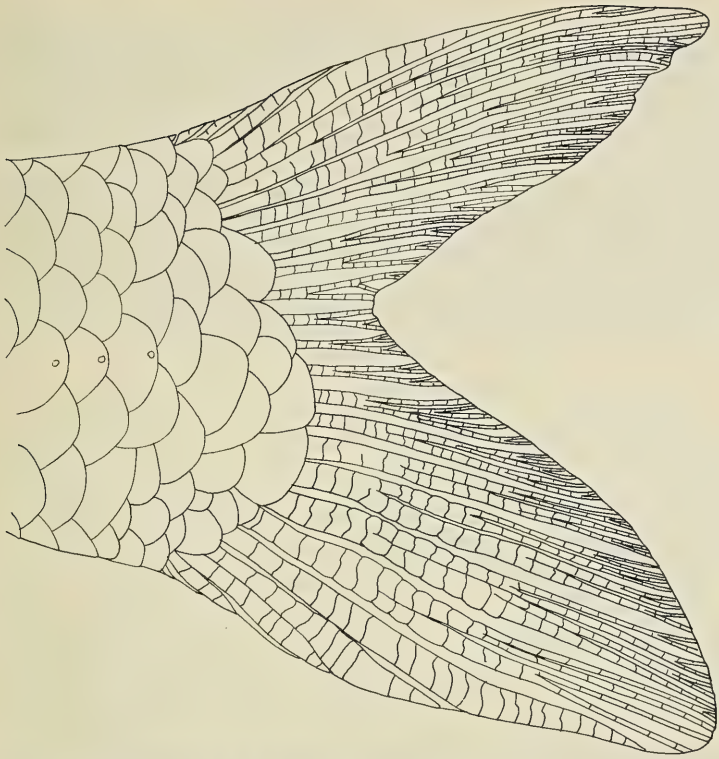


Fig. 1. Caudal fin of *E. bayano*, male, 52.3 mm, in breeding condition, from USNM 214006.

of large adult females often asymmetrical but not as much as in males. Monotypic.

Other characters of the genus include: premaxillary with an irregular row of 4–6, usually 5, tricuspid outer row teeth and four inner row teeth with 5–6 cusps. Lateral line complete. Third infraorbital well ossified, contacting horizontal limb of preopercle ventrally and with a naked area between itself and vertical limb of preopercle. Dorsal fin, pelvic fins, pectoral fins, and anal fin with spinules in breeding males. Caudal fin with irregular scales at base, some somewhat enlarged, especially on the lower caudal fin lobe. Caudal peduncle of males much deeper than in females. Precaudal vertebrae 17–18; total vertebrae 37–38.

*Etymology*: From *eretmon*, meaning paddle, referring to the paddle-like lower caudal fin lobe, and *Brycon*, a genus of American characids.

FIG. 2. Holotype of *E. bayano*, male, 51.7 mm, USNM 213842.

**Eretmobrycon bayano**, new species
Figures 1–4

*Holotype*: USNM 213842, male 51.7 mm SL; Panamá, Bayano river basin, pool in small stream about 19 km along road from El Llano to Carti, about 0.5 km downstream from the road. Collected 10 March, 1973 by J. D. McPhail and R. Dressler.

*Paratypes*: All with same data as holotype: USNM 213843, 22 specimens 32.1–55.9 mm; ANSP 130186, 2, 46.5–53.6 mm; CAS 31895, 2, 43.2–46.8 mm; BMNH 1975.2.3.1–2, 2, 43.6–46.9 mm; ZMA 113.490, 2, 49.0–52.1 mm.

*Other specimens*: USNM 214006, Panamá, Bayano river basin, first stream on road from El Llano to Carti, approximately 11 km from main road between Chepo and Bayano Dam sites, collected 24 Jan. 1974 by D. L. Kramer, 7 specimens 41.9–52.9 mm (1 specimen cleared and stained); USNM 214007, 40 specimens 30.4–57.5 mm, same data as USNM 214006, but collected 15 Jan. 1975; USNM 214664, 36 specimens 16.8–53.9 mm, same data as USNM 214006, but collected 23 April 1975.

*Description*: The following description is based on specimens selected over the size range from the types and USNM 214006. Standard length of examined specimens 40.4–55.9 mm. Body elongate, compressed laterally, greatest body depth 27.7–34.7 percent. Predorsal profile convex with a slight concavity at nape. Profile between posterior dorsal fin base and anterior adipose fin base slightly convex, with a slight dip at adipose fin base. Posterior to adipose fin, profile slightly concave to upper procurrent caudal fin rays. Distance from eye to dorsal fin 35.0–38.9; distance from dorsal fin origin to end of caudal peduncle 50.6–55.0. Ventral profile gently rounded from jaws to anus; steepest inclination ventral to jaws. Ventral profile with greatest protrusion just anterior to pelvic fin. Profile along anal fin base straight in females, slightly concave anteriorly and slightly convex posteriorly in males; between anal fin and procurrent caudal rays, body profile concave in females, convex in males. In males, lower procurrent caudal fin rays protrude more than upper procurrent rays. Caudal peduncle depth 11.6–15.8 (Fig. 5); peduncle length 11.6–14.7.

Fig. 3. Female paratype of *E. bayano*, 54.3 mm, USNM 213843.

Head length 24.2–27.8. Eye diameter 9.1–11.1. Snout length 6.1–8.1. Least bony interorbital width 7.5–8.8. Maxillary sloping ventrally and posteriorly, forming an angle of 50–60 degrees to longitudinal body axis; upper jaw length 10.4–12.9. All teeth with median cusp longest. Premaxillary with 4 inner row teeth each with 5–6 cusps, and 4–6, usually 5 tricuspid outer row teeth; first, third, and fifth outer row teeth set slightly anterior to other outer row teeth. Maxillary with 2–3, usually 2, teeth each with 5–7 cusps. Dentary with 4 large quinquecuspid teeth anteriorly, 4–6 tricuspid to conical teeth posteriorly; second tooth from symphysis offset slightly anterior to tooth row; fourth tooth from symphysis curves slightly posteriorly. No teeth present on vomer, palatines or pterygoids.

Fontanels moderately long, that part anterior to epiphyseal bar about half the length of that part posterior to bar. Gill rakers moderate, 15 counted in the cleared and stained specimen. Circumorbital bones well ossified; infraorbital 2 wide, no fleshy area ventral to it; infraorbital 3 wide, contacting preopercle ventrally; a fairly wide area of skin posterior to infraorbital 3.

Scales moderately large, cycloid, with concentric circuli and 0–10 radii on exposed posterior field. Lateral line complete, with 37–39, usually 37–38 perforated scales. Lateral line often with a slightly irregular ventral curve on side of body from origin to below dorsal fin, then continuing with a gentle irregular dorsal curve to caudal fin base. Scales above lateral line 6–7 (rarely 7); scales below lateral line 5. Predorsal scales 12–13. Scale sheath at anal fin base of about 8–10 scales in a single row. Axillary scale present dorsal to pelvic fin insertion. Base of caudal fin with irregular scales, some somewhat enlarged, especially on lower caudal fin lobe (Fig. 1).

Dorsal fin with 2 anterior unbranched rays and 9 (8[4], 9 [22]) branched rays. Dorsal fin origin anterior to anal fin origin, posterior to pelvic fin origin, nearer eye than caudal fin base. Distance from tip of snout to dorsal fin origin 48.9–54.0. Third or fourth ray of dorsal

FIG. 4. Live specimen of *E. bayano*, male, 52.9 mm, same locality data as USNM 214006, collected 23 April 1975 by D. Kramer.

fin longest, posterior rays shorter, forming rounded posterior margin of fin; length of longest ray 22.9–26.7. In breeding males minute spinules present, sparingly, on first through fourth branched dorsal fin rays. The spinules occur singly, primarily on the posterior main ray branch segments, more numerous distally.

Anal fin with v (vi[9], vii[16]) unbranched rays and 28 (26[1], 27[2], 28[13], 29[7], 30[2]) branched rays. First through third or fourth unbranched rays usually visible only in radiographs or cleared and stained specimens. Origin of anal fin posterior to midpoint of standard length 57.6–64.0. Posteriormost unbranched ray and first through seventh or eighth branched rays longer, with successive posterior rays shorter, forming an abruptly protruding fin margin anteriorly and a straight margin posteriorly. Dorsally recurved anal fin spinules present in adult breeding males; these occur on the posteriormost unbranched ray and on as many as all branched rays in males in full breeding condition. Spinules present on posterior edge of fin rays, usually in bilateral pairs, with one spinule pair per bony ray segment. Spinules less numerous on anterior branches of branched rays than on posterior branches. On extreme distalmost segments of anterior ray branches, spinules may be on anterior margin of ray segments instead of posterior margin. Non-breeding males may have small nubbins instead of spinules. Fin often fleshy around spinules. Anterior branched anal fin rays in all males somewhat thicker than corresponding rays in females.

Pectoral fin with one unbranched ray and 10 (9[1], 10[15], 11[11]) branched rays. Pectoral fins reach slightly beyond pelvic fin origin. Distance from tip of snout to dorsal end of pectoral fin base 24.7–27.8 and length of pectoral fin from base to tip of longest ray 21.1–24.3. Small spinules present in fully developed breeding males on first unbranched ray and first through fifth to seventh branched rays; most spinules point ventral-ward and are on posterior edges of rays, one or

two to a bony ray segment. A few dorsal-pointing spinules on longest rays, one to a ray segment (these may occur on ray segments along with two ventral-pointing spinules).

Pelvic fin with i,8 rays in all specimens, distal fin tip reaching just before or just to anal fin origin. Distance from tip of snout to pelvic fin origin 40.6–46.4; pelvic fin length 14.8–18.2. Males with antero-ventral pointing spinules on all pelvic fin rays. Spinules occur primarily distal to branching point of branched rays on anteriormost four fin rays, but occur proximal to that point in more posterior rays, area covered progressively increasing with each successive ray. Spinules more numerous on posterior main branch of ray; when main ray branches branched, spinules more numerous on posterior branch of secondary branch. Spinules occur singly or in pairs on each bony ray segment. When only one spinule present, it occurs on posterior edge of segment; when in pairs, spinules on both anterior and posterior edge of ray segment (posterior spinule of pair is first to develop). Paired spinules occur primarily on posterior main ray branch, but are commonly found on anterior main ray branch on more posterior fin rays.

Caudal fin with 10/9 principal rays in all specimens; fin forked, not split to base. In adult males and large adult females, lower lobe much larger than dorsal lobe; posteriormost two ventral procurrent rays and rays 9–4 (numbering ventralmost principal caudal ray as 9) enlarged and dorsoventrally expanded; this condition more extreme in males than in females (Figs. 1–3). In small females and immature males caudal fin symmetrical. No spinules on caudal fin rays.

Precaudal vertebrae 17 (17[12], 18[12]). Total vertebrae 38 (37[6], 38[19]).

*Color in alcohol*: Ground color cream brown. Scales of back and sides to midline with large dark chromatophores on inner surface of free margin forming a reticulate pattern. In dermis adherent to inner scale surface, anterior to large chromatophores, occur numerous smaller black chromatophores. Numerous, less dark chromatophores approximately size of marginal scale chromatophores, in dermis medial to scales (and medial to layer adherent to scales). Anteriorly, ventral to lateral midline, small black chromatophores less numerous; more ventrally, large chromatophores less regular and less numerous with loss of reticulate pattern. No chromatophores on belly. Above anal fin, ventral to lateral midline, most chromatophores black, of dermal type, irregularly placed, partially following myomere junctions. Dark stripe posteriorly along lateral midline, becoming concentrated into a rounded caudal blotch. Dark chromatophores extend to distal ends of middle caudal fin rays. Numerous small dark chromatophores cover top of head and lower lip, extend along maxillary, around orbital rim, anteriorly along vertical preopercle limb, and on opercular skin flap. Larger, less dark chromatophores loosely scattered under infraorbital bones and opercle. No well defined humeral spot.

Dorsal fin with numerous dark chromatophores along fin rays and on

interradial membrane immediately adjacent to fin rays, often more concentrated at fin base. Adipose fin with numerous small dark brown chromatophores. Caudal fin with dark chromatophores along dorsal and ventral ray surface and on interradial membrane along posterior fin margin; numerous small dark chromatophores along dorsal margin of dorsal lobe and ventral margin of ventral lobe. Anal fin with small brown chromatophores along rays and on interradial membrane. Pelvic fins and pectoral fins with dark chromatophores along fin rays; no chromatophores on interradial membrane.

*Color in life*: Body light olive brown above and silvery white below a mid-lateral band of silver or greenish gold (color of band depends on angle of light reflection). Band along posterior two-thirds of body. Dark caudal spot and faint humeral spot present. Males with yellow at base of upper caudal fin lobe and in middle of lower caudal fin lobe; faint black streaks along fin rays on lower caudal fin lobe. Dorsal fin slightly dusky; other fins nearly hyaline. Iris of eye silvery except for yellow spot dorsally. Female coloration similar to males but yellow on caudal fin fainter.

Color description based on information supplied by D. Kramer and from live specimens kept in aquaria; see Fig. 4 for color pattern in life.

*Ecology*: According to Drs. McPhail and Kramer (in litt.), the watershed of the habitat of *E. bayano* consists of heavily forested steep hills. The type-collection was made in a small stream, in a rocky-bottomed pool about 15 m long, 8 m wide, and less than 50 cm deep. Dr. Kramer collected in a small stream of moderate gradient with pools alternating with riffles and small falls; mean width of the stream is about 3 m, depth rarely over a meter. The stream bed is sandy with some stones and ledge (except where thick red clay eroded from the road has covered the bottom) and moderate cover in the form of forest debris; the stream has no aquatic macrophytic vegetation. Stream temperature in mid-January (early dry season) in mid-afternoon was 24.5° C.; stream flow was estimated by Kramer at about 0.05 $m^3$/sec.

Other genera of fishes collected with *E. bayano* included *Brachyraphis, Brycon, Bryconamericus, Chaetostoma, Hypopomus, Poecilia, Pygidium,* and *Rivulus.*

Dr. McPhail examined stomach and gut contents of *E. bayano* collected at midday. Although most stomachs were empty, the intestines of many specimens contained seeds, terrestrial insects, and in two individuals a few fish scales (not of *Eretmobrycon*). In five specimens Dr. Kramer found aquatic insect larvae, terrestrial insects, and algae to be important components of the stomach contents.

*Sexual dimorphism and reproduction*: Mature non-breeding males of *E. bayano* can be distinguished from females by the enlarged rays of the lower caudal fin lobe. In some large females these rays are somewhat enlarged but not as much as in males. Sexually ripening or second and third year males which have bred, have poorly developed or reduced spinules on the anal fin rays. Breeding males are easily identified

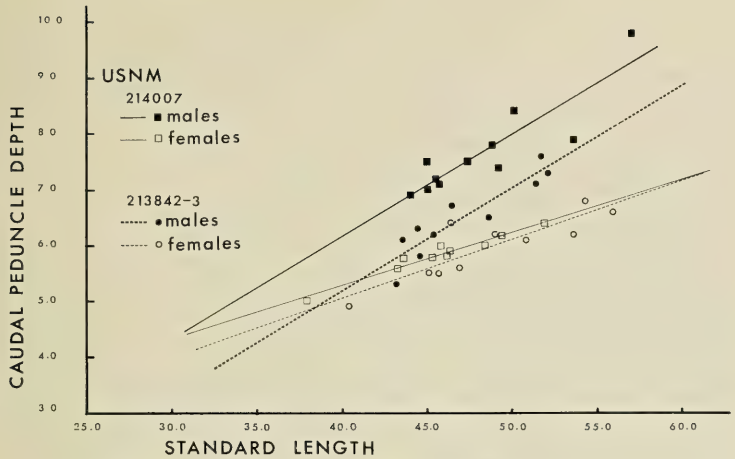



Fig. 5. Caudal peduncle depth related to SL in two populations of *E. bayano*, USNM 214007, breeding; USNM 213842–3, non-breeding. Linear regressions are plotted for males and females of each population.

by their well-developed complement of spinules on all fins but the caudal fin, and large testes; breeding females have plump bellies and ripe ova.

Caudal peduncle depth is greater in males than in females (Fig. 5), and the limited data suggest that peduncle depth in males increases during sexual ripening. The non-breeding males of USNM 213843 and USNM 214664 (the latter not shown in Fig. 5) have virtually identical caudal peduncle depths (these populations come from close, but not identical localities). The breeding males of USNM 214007 have significantely greater caudal peduncle depth than the non-breeding males just mentioned. Note that USNM 214664 and USNM 214007 are from the same locality and presumably represent the same population in breeding and non-breeding condition. Also note (Fig. 5) that caudal peduncle depth of females is very similar in breeding and non-breeding populations.

Dr. Kramer (in litt.) indicates that the smallest maturing male he has examined was 43 mm SL and the smallest maturing female was 40 mm SL. His studies suggest that breeding is seasonal (January to February), and that the breeding population consists primarily of two-year fishes, with a few three-year fish breeding a second time. A large number of specimens in the population samples seem to be immature one-year fish.

*Relationship*: A thorough phylogenetic analysis of characters that could be used to infer the relationships of *Eretmobrycon* cannot be undertaken at this time. As discussed by Fink and Weitzman (1974)

and Weitzman and Fink (in press), current knowledge of the distribution and lability of many morphological structures traditionally used in characid systematics is woefully inadequate. Determination of the usefulness in classification of such characters as number and shape of premaxillary and maxillary teeth, fin specializations, and size of the third infraorbital is a long-term project and involves examination of many characids from Central and South America and Africa. Such studies are underway. Given this disclaimer, it is possible to speculate on the affinities of *E. bayano* and the validity of the genus.

The characters of *E. bayano* that have prompted erection of a new genus, i.e., the pelvic fin ray count and the specialized caudal fin structure, are of unknown phylogenetic significance. The species cannot be placed in any existing genus without causing a major redefinition of that genus. It may be that future studies will indicate that *E. bayano* should simply be placed in *Bryconamericus*. Until those studies, including a thorough revision of *Bryconamericus* and related genera, are possible, it seems best to recognize the unique specializations of *E. bayano* and place it in a monotypic genus.

Of the genera in Central America and northern South America, *Eretmobrycon* seems most probably related to *Bryconamericus* and *Astyanax*. Members of these genera are rather morphologically and ecologically generalized and widely distributed, especially in South America. The supposed differences between *Astyanax* and *Bryconamericus* may eventually be considered unimportant at the generic level. There are four characters which have been used to separate the two genera:

(1). The number of inner row premaxillary teeth (5 in *Astyanax*, with a few species having 4; 4 in *Bryconamericus*). It becomes evident in reading Eigenmann (1921), that in a small number of species of *Astyanax* the tooth counts cannot be used in generic placement. This is a common problem in systematics of characids; many characters can be used to differentiate species or genera in limited geographical areas, but nearly every systematic character used is labile to such a degree that in some geographical areas generic or species definitions based on these characters break down. Many characid genera "grade" into one another and until a thorough analysis of systematic characters used is completed, this unacceptable situation will remain.

(2). Regular, in *Astyanax*, or irregular, in *Bryconamericus*, placement of the outer row premaxillary teeth was used by Meek and Hildebrand (1916) for separation of these two genera. The outer row teeth may be in a regular series or some may be slightly displaced relative to the other outer row teeth. Although this character is useful in separating the genera in at least some parts of Panamá (Kramer, pers. comm.), Eigenmann (1927) states (and I concur) that among species of *Bryconamericus* over a wide geo-

graphical range, the outer tooth row may be either regular or irregular depending on the species.

(3). Width of third infraorbitals (*Astyanax* has a narrow fleshy area between the third infraorbital and the horizontal limb of the preopercle while *Bryconamericus* has the third infraorbital touching the horizontal limb of the preopercle). This kind of difference has been used to differentiate several characid genera. Eigenmann (1921, 1927) numbered the infraorbitals differently than is done currently; his suborbital 2 is actually infraorbital 3 (see Weitzman, 1962: 28 for a discussion of the osteology of characid orbital bones). Eigenmann diagnosed *Astyanax* as having a naked area ventral to the "second suborbital" (infraorbital 3 of Weitzman) and *Bryconamericus* as having the "suborbital" touching the preopercle ventrally. The character is useful, at least in Panamá. He further defined *Astyanax* as having a naked (fleshy) triangle below the joint between the "first and second suborbitals" (= 2 and 3 infraorbitals) while in *Bryconamericus* there is no naked triangle below the "suborbitals." I have found in cleared and stained specimens that the amount of "naked" area is somewhat variable and simply a function of the size of the third infraorbital; when the third infraorbital is large enough to touch the preopercle ventrally, it is also large enough to touch the second infraorbital along the posteroventral edge of that bone.

(4). Kind and distribution of adult male anal fin hooks and spinules are characters I have found to be of use in Central America. Mature *Astyanax* males have bony hooks on the segments of the fourth unbranched ray and the first through seventh to ninth branched rays, the hook tips pointing toward the fin base. In the sexually ripe *Bryconamericus* males examined, spinules, not hooks as found in most characids, are present on the last unbranched ray and all branched rays, from near the ray bases to their distal tips. These spinules are very thin and point toward the distal ends of the rays in some species and toward the fin base in other species. In fact, on some Panamanian *Bryconamericus*, these spinules covered all of the fins, including pelvic and pectoral fins, dorsal fin, and dorsal and ventral caudal fin lobes. Previous investigations (Fink and Weitzman, 1974), and information supplied by D. Kramer (pers. comm.) indicate that presence of fin spinules or hooks is dependent on breeding season in at least some characids and that different species may be sexually active at different times of the year in the same geographical area. Therefore, care must be exercised in interpreting presence or absence of the structures in these fishes.

Of the four characters mentioned above, *Eretmobrycon* shares (1), (2), (3), and (4) in part, with *Bryconamericus* and not with *Astyanax*.

In dentition and shape of the infraorbital bones, *Eretmobrycon* is virtually identical with *Bryconamericus*. In character (4), *Eretmobrycon* agrees with *Bryconamericus* in having spinules on the last unbranched and all branched anal fin rays. However, the spinules of *Eretmobrycon* are slightly "heavier" (thicker) than the spinules of *Bryconamericus* (although not nearly as massive as the hooks of *Astyanax*). The spinules of *Eretmobrycon* point toward the fin base as in *Astyanax*, not the distal fin edge as in some *Bryconamericus*. Again, we are dealing with a character of unknown phylogenetic significance. Hooks, as found in *Astyanax*, are more commonly found in characids than spinules. The distribution of spinules in characid species clearly not closely related (e.g., *Bryconamericus*, *Carlana* [Fink and Weitzman, 1974], and some "glandulocaudin" genera [Weitzman and Thomerson, 1970], indicates that their presence is probably a convergent specialization appearing throughout the Characidae. Therefore, their presence in *Bryconamericus* and *Eretmobrycon*, while suggestive, cannot be taken as evidence of close relationship.

The presence of four premaxillary inner row teeth is another character common to *Eretmobrycon* and *Bryconamericus*. *Astyanax* usually has five inner row teeth. I expect that four teeth is more specialized than five teeth, and is probably related to mouth size and feeding specializations. As mentioned above, this character should be used with caution because of its lability.

Tubercles (hypertrophied patches of epidermal cells) are present on breeding *Bryconamericus* males from Panama and are absent on *Astyanax* and *Eretmobrycon*. These structures may be found to be important characters but their evaluation is beyond the scope of this paper.

It is reasonable to question the establishment of a new genus for *E. bayano* in view of the overabundance of generic names of Neotropical Characidae. *Eretmobrycon bayano* has one specialization found in no other characids (the hypertrophied lower caudal fin lobe) and another (the pelvic fin ray count of i,8) found only in the genus *Crenuchus*, a highly specialized form belonging to a very different characoid lineage. Since these characters are autapomorphic at this level they are of no use in determining relationships.

Traditionally important systematic characters suggest relationship between *Eretmobrycon* and *Bryconamericus* and the latter may eventually be where *E. bayano* is placed. Nevertheless, my examination of many nominal species of *Bryconamericus* strongly suggests that that genus is polyphyletic and consists of a number of difficult to define lineages. For instance, at least some Central American species of *Bryconamericus* may someday be placed together as a natural group, based in part on the presence of breeding tubercles. I do not believe that *E. bayano* can be precisely related to any species now currently placed in *Bryconamericus* and hesitate to place it in an already polyphyletic genus. It is possible that *E. bayano* is not related to any existing species of *Bryconamericus* but is a specialized relict of a *Bryconamericus*-like form

that entered Panama before the ancestor(s) of *Bryconamericus* now living there. Alternatively, *E. bayano* may be descended from the common ancestor of one of the lineages of *Bryconamericus*.

If *Eretmobrycon bayano* did arise from a *Bryconamericus*-like ancestor, subsequent evolution has resulted in specializations which clearly set it apart from the known species of that genus, i.e. the increase of one pelvic fin ray and the hypertrophied lower caudal fin lobe. The caudal fin lobe hypertrophy in adults, especially males, is perhaps related to breeding behavior. Determination of the function of this particular morphological specialization must await aquarium or field observations of spawning.

*Etymology*: The specific epithet *bayano* refers to the river basin in which the species seems to be endemic.

*Resumen*

En el presente trabajo se describe *Eretmobrycon bayano*, neuvo género y nueva especie de la familia Characidae del río Bayano, Panamá. El género *Eretmobrycon* se caracteriza por tener i,8 radios pélvicos, radios caudales del lóbulo inferior muy hipertrofiados (particularmente en los machos) y dos filas de dientes premaxilares.

Los machos de *E. bayano* que no han alcanzado la época de la reproducción, se distinguen de las hembras por poseer radios caudales hipertrofiados y un pedúnculo caudal más alto. En contraste con los machos antes descritos, los machos reproductores tienen los radios inferiores de la aleta caudal más alargados, el pedúnculo caudal más alto y los radios de todas las aletas, excepto la caudal, recubiertas de espínulas.

El desove tiene lugar en enero y febrero de cada año y la mayoría de la población reproductora está formada por individuos de dos años y algunos de tres años que posiblemente desovan por segunda vez.

El habitat propio de la especie son arroyos de montañas poco profundos, en vertientes con una vegetación boscosa. Su dieta básica consiste en semillas, larvas de insectos acuáticos, insectos terrestres y algas.

Con la finalidad de determinar las relaciones del género *Eretmobrycon*, se presenta un breve análisis filogenético de varios caracteres sistemáticos usados para definir a *Astyanax* y *Bryconamericus*. El número de dientes premaxilares en la fila interna (5 en *Astyanax*, aunque algunas especies tienen 4; 4 en *Bryconamericus*) es un carácter útil para la separación de estos géneros en una región geográfica determinada; sin embargo, la similitud del número de dientes entre algunas especies de los dos géneros impide el empleo de este carácter para una diferenciación genérica. La regularidid (en *Astyanax*) o irregularidad (en *Bryconamericus*) de la fila externa de dientes premaxilares es un carácter bueno para distinguir los dos géneros en algunas localidades de Panamá, pero en especies de *Bryconamericus* de un ámbito geográfico más amplio, la fila externa de dientes premaxilares puede ser regular o irregular dependiendo de la especie. El ancho del tercer infraorbitario (= segundo suborbitario de Eigenmann) y el área "desnuda" asociada, son útiles

para la separación de los dos géneros en muestras de Panamá, pero son demasiado variables para el diagnóstico, cuando se incluyen especies de la América del Sur. El tipo y distribución de ganchos y espínulas en las aletas, son caracteres útiles, por lo menos en la América Central. Los machos adultos de *Astyanax* tienen ganchos óseos en los radios pélvicos y en los radios anteriores de la aleta anal, mientras que en *Bryconamericus* presentan espínulas más delicadas, que a veces se encuentran en todas las aletas. Aunque los ganchos y espínulas de las aletas aparecen sólo en la época de la reproducción, son eventualmente útiles para definir, por lo menos, algunos de los géneros de la familia Characidae, incluyendo linajes actualmente ubicados en *Astyanax* y *Bryconamericus*.

*Eretmobrycon* y *Bryconamericus* son muy similares en los caracteres discutidos anteriormente, difiriendo sólo en detalles morfológicos de las espínulas. *E. bayano* podría ser considerado como una especie de *Bryconamericus*, pero si aceptamos que este último género es polifilético y que las posibles relaciones de *E. bayano* con las otras especies del género son aún ignoradas, es mejor reconocer por el momento que el número peculiar de radios pélvicos y las especializaciones de la aleta caudal de la nueva especie son al mismo tiempo caracteres de un nuevo género.

## Literature Cited

Eigenmann, C. H. 1921. The American characidae. Mem. Mus. Comp. Zool. 43 (3):209–310.

———. 1927. The American characidae. Mem. Mus. Comp. Zool. 43(4):311–428.

Fink, W. L., and S. H. Weitzman. 1974. The so-called cheirodontin characids of Central America, with descriptions of two new species (Pisces: Characidae) Smithsonian Contrib. Zool. No. 172:46 pp.

Meek, S. E., and S. F. Hildebrand. 1916. The fishes of the freshwaters of Panama. Field Mus. Nat. Hist., Zool. Ser. 10(15): 217–374.

Weitzman, S. H. 1962. The osteology of *Brycon meeki*, a generalized characid fish, with an osteological definition of the family. Stanford Ichthyol. Bull. 8(1):1–77.

Weitzman, S. H., and J. E. Thomerson. 1970. A new species of glandulocaudine characid fish, *Hysteronotus myersi*, from Peru. Proc. Calif. Acad. Sci. 38(8):139–156.

Weitzman, S. H., and W. L. Fink. In press. The interrelationships of the neon tetras, a unique group of South American characids (Pisces), with comments on the phylogeny of new world characoid fishes. Smithsonian Contrib. Zool.

QH
1
B4X
NH

No. 31, pp. 345–350 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES
SMITHSONIAN
1976

# *GLYPHIDODONTOPS SPRINGERI*, A NEW SPECIES OF DAMSELFISH (POMACENTRIDAE) FROM THE PHILIPPINE AND MOLUCCA ISLANDS

By Gerald R. Allen and Roger Lubbock
*Department of Fishes, Western Australian Museum*
*Perth 6000, Australia, and*
*Zoology Department, University College, London,*
*Gower Street, London WC1 E6BT*

The damselfishes (Pomacentridae) are one of the dominant fish groups of tropical reefs in both species and individuals. In spite of their abundance the classification of these fishes remains poorly understood. The majority of species have been assigned by most previous authors to *Chromis*, *Abudefduf* or *Pomacentrus*. The taxonomy of the latter two genera is particularly confusing. Allen (1975) provisionally recognizes 21 genera from the Indo-West Pacific. His classification represents a modification of that proposed by Bleeker (1877). In his study, the genus *Abudefduf* is restricted to relatively large species characterized by 3 to 4 scale rows above the lateral-line and uniserial teeth. Many of the species have alternating light and dark bars on the sides. The genus is typified by the well known circumtropical species, *A. saxatilis*. The majority of species previously included in *Abudefduf* are assigned to *Glyphidodontops* Bleeker. The salient features of this genus include a relatively small size (usually less than 80 mm standard length at maturity) and an elongate body (depth generally in excess of 2.0 in standard length). Many of the species are brightly colored and most exhibit biserial dentition, at least at the front of the jaws. This paper describes a member of this genus which was recently collected in the Philippine and Molucca Islands.

TABLE 1. Counts from 30 type-specimens of *Glyphidodontops springeri*

| Locality | Dorsal rays | | | | | | | Gill rakers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | XI | XII | XIII | 10 | 10½ | 11 | 11½ | 21 | 22 | 23 | 24 | 25 |
| Molucca Islands | 2 | 18 | 1 | 1 | 4 | 11 | 5 | 2 | 6 | 10 | 3 | |
| Philippine Islands | | 9 | | | 3 | 3 | 3 | | 3 | 2 | 3 | 1 |

| | Tubed lateral-line scales | | | | | | Anal rays | | | | Pectoral rays | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 11 | 12 | 13 | 14 | 15 | 16 | 10 | 10½ | 11 | 11½ | 14 | 15 | 16 |
| Molucca Islands | | 10 | 9 | 2 | | | 1 | 2 | 18 | | 5 | 15 | 1 |
| Philippine Islands | 1 | | 1 | 5 | 1 | 1 | | 6 | 3 | | | 9 | |

The methods of counting and measuring are the same as those described by Allen (1972), except the length of the dorsal and anal spines are measured proximally at the base of the spine rather than the point at which the spine emerges from the scaly sheath. Measurements were made with needle-point dial calipers to the nearest millimeter (mm). Standard length is abbreviated as SL. The fraction ½ appearing in the dorsal and anal fin ray formulae refers to a bifurcate condition of the last ray.

The counts and proportions which appear below in parentheses apply to the paratypes when differing from the holotype. A summary of counts for the dorsal, anal, and pectoral fin rays, gill rakers on the first arch and tubed lateral-line scales is presented in Table 1. Proportional measurements of the holotype and several paratypes are expressed as percentages of the standard length in Table 2.

Type-material has been deposited in the following institutions: Bernice P. Bishop Museum, Honolulu (BPBM); British Museum (Natural History), London (BMNH); National Museum of Natural History, Washington (USNM); Western Australian Museum, Perth (WAM).

TABLE 2. Morphometric proportions (in % of SL) of *Glyphidodontops springeri*

| Character | Holotype USNM 213577 | Paratypes BMNH 1974.8.22.1–9 | | USNM 209652 | USNM 209838 | USNM 209652 |
|---|---|---|---|---|---|---|
| Standard length (SL) | 33.6 | 37.5 | 35.4 | 32.2 | 28.4 | 23.4 |
| Body depth | 494 | 483 | 466 | 494 | 518 | 500 |
| Head length | 333 | 312 | 314 | 335 | 342 | 342 |
| Snout length | 68 | 77 | 68 | 78 | 67 | 68 |
| Eye diameter | 110 | 115 | 119 | 121 | 141 | 137 |
| Interorbital width | 92 | 88 | 96 | 93 | 99 | 107 |
| Least depth caudal peduncle | 149 | 155 | 155 | 149 | 144 | 150 |
| Length caudal peduncle | 137 | 147 | 153 | 130 | 116 | 124 |
| Snout to origin dorsal fin | 366 | 349 | 376 | 391 | 380 | 385 |
| Snout to origin anal fin | 664 | 659 | 641 | 696 | 701 | 658 |
| Snout to origin pelvic fin | 381 | 432 | 390 | 404 | 430 | 397 |
| Length dorsal fin base | 586 | 587 | 613 | 590 | 574 | 564 |
| Length anal fin base | 250 | 232 | 243 | 258 | 254 | 256 |
| Length pectoral fin | 268 | 245 | 198* | 280 | 296 | 282 |
| Length pelvic fin | 283* | 333 | 268* | 311 | 246* | 291 |
| Length pelvic spine | 152 | 179 | 184 | 186 | 180 | 205 |
| Length 1st dorsal spine | 65 | 64 | 76 | 78 | 74 | 77 |
| Length 5th dorsal spine | 185 | 192 | 212 | 208 | 215 | 214 |
| Length 12th dorsal spine | 131 | 149 | 147 | 140 | 123 | 128 |
| Length longest soft dorsal ray | 202 | 205 | 155* | 211 | 215 | 235 |
| Length 1st anal spine | 77 | 96 | 102 | 96 | 85 | 81 |
| Length 2nd anal spine | 149 | 189 | 105* | 189 | 197 | 150 |
| Length longest anal ray | 217 | 165* | 124* | 205 | 222 | 235 |
| Length middle caudal rays | 304 | 253* | 141* | 313 | 313 | 312 |

* damaged

**Glyphidodontops springeri**, new species

Figure 1

*Holotype*: USNM 213577, 33.6 mm SL, collected with rotenone in 8 m off east shore of Piru Bay, Tandjung Liang, Ceram, Molucca Islands by V. Springer and M. Gomon, 10 January 1973.

*Paratypes*: BMNH 1974.8.22.1–9 (9 specimens, 24.2–37.5 mm SL) collected with dipnets in 20–30 m off Cebu, Philippine Islands, 1974; BPBM 18618 (3, 18.9–33.6 mm) collected with holotype; USNM 209652 (45, 9.6–34.0 mm) collected with holotype; USNM 209838 (5, 17.0–28.4 mm) collected with rotenone in 5–7 m at Piru Bay, Ceram, Molucca

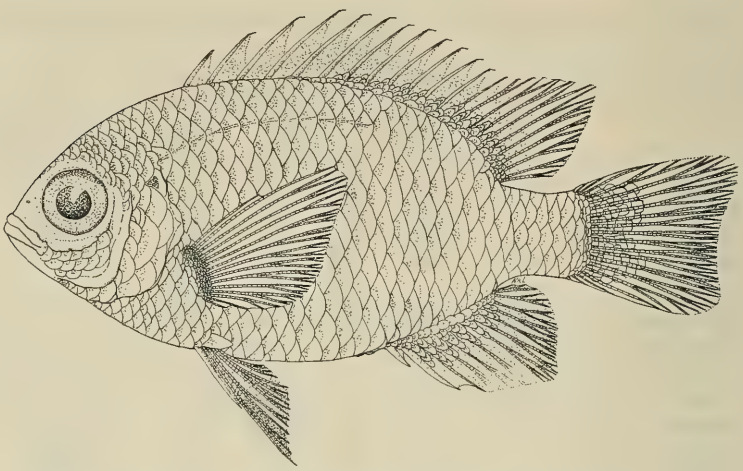


FIG. 1. *Glyphidodontops springeri*, holotype, USNM 213577, 33.6 mm SL, Ceram, Molucca Islands (drawing by Helen K. Larson).

Islands by V. Springer and M. Gomon, 9 January 1973; WAM P25127-001 (3, 18.9–33.6 mm) collected with holotype.

*Diagnosis*: A species of *Glyphidodontops* with the following combination of characters: dorsal spines usually 12; pectoral rays usually 15; tubed lateral-line scales usually 12 to 14; color mostly blackish (brown in preservative) with bright blue streaks on most scales of lower half of sides.

*Description*: Dorsal rays XII,10½ (XI to XIII,10 to 11½); anal rays II,11 (II,11 or 11½); pectoral rays 15 (14 to 16); pelvic rays I,5; branched caudal rays 13; gill rakers on first arch 23 (21 to 24); tubed lateral-line scales 12 (11 to 15); vertical scale rows from upper edge of gill opening to base of caudal fin 27 (27 or 28); horizontal scale rows from base of dorsal fin to posteriormost scale of tubed lateral-line (exclusive of sheath scales at dorsal base) 1; from lateral-line to anal fin origin 8; predorsal scales about 17 (16 to 18), extending to front margin of orbits; teeth of jaws biserial (inner row of teeth poorly developed and apparent only under high magnification; best observed at middle of lower jaw), more or less incisiform with truncate to slightly notched tips.

Body ovate, laterally compressed, greatest depth 2.0 (1.9 to 2.1) in SL. Head profile conical; head length 3.0 (2.9 to 3.2) times in SL. The following characters are expressed as proportions of the head length: snout 4.9 (4.0 to 5.1), eye diameter 3.0 (2.4 to 2.7); interorbital width 3.6 (3.2 to 3.6), least depth caudal peduncle 2.2 (2.0 to 2.4), length caudal peduncle 2.4 (2.1 to 2.9), pectoral fin length 1.2 (1.2 to 1.3), pelvic fin length 1.2 (0.9 to 1.2), caudal fin length 1.1 (1.1 to 1.2).

Single nasal opening on each side of snout; mouth oblique, terminal; lateral-line gently arched beneath dorsal fin, terminating at scale row below base of ninth dorsal spine; preorbital, suborbital, tip of snout, lips, chin and isthmus naked; remainder of head and body scaled; scales finely ctenoid; preopercular scale rows 2, an additional row of smaller scales covering anterior part of inferior limb; small sheath scales covering approximately one-third to one-half of membranous basal portions of dorsal, anal, and caudal fins; margin of preorbital, suborbital, and preopercle entire; margin of opercle with flattened spine at angle and another near upper corner of gill opening.

Origin of dorsal fin above third tubed scale of lateral-line; anterior spines of dorsal fin gradually increasing in length to about fifth or sixth spine, remaining spines gradually decreasing in length. The following characters are expressed as proportions of the head length: length first dorsal spine 5.1 (4.1 to 4.9), fifth dorsal spine 1.8 (1.5 to 1.6), last dorsal spine 2.5 (2.1 to 2.8), longest soft dorsal ray 1.6 (1.5 to 1.6), first anal spine 4.3 (3.3 to 4.2), second anal spine 2.2 (1.6 to 2.3), longest soft anal ray 1.5 (1.5 to 1.6).

*Color in alcohol*: Head and body of holotype mostly uniform brownish-blue, lighter on breast and caudal peduncle; spinous dorsal and anterior portion of pelvic and anal fins brownish-blue or dusky; remainder of fins pale; pectorals with black spot covering base.

Paratypes from the Molucca Islands are similar in color although many were damaged and exhibit missing scales and tan splotches on the head and body. The largest paratypes (33.5–37.5 mm SL) from Cebu, Philippine Islands are more colorful with many of the body scales pale blue. There are also scattered blue spots on the head and three pale blue stripes; one extending from top of eye to snout tip; another, very short, from anterior edge of eye to upper lip; and one on suborbital. A small black spot present at upper corner of the gill opening and another on upper pectoral base. Smaller specimens from Cebu are similar to those from the Moluccas.

*Color in life*: Based on a 35-mm transparency of a paratype from Cebu, photographed in an aquarium: Ground color of head and body blackish; head and lower two-thirds of body with numerous blue scales, those on body giving the appearance of narrow blue streaks; blue lines passing through upper and lower portions of eye; similar blue lines on snout; spinous dorsal fin blue; soft dorsal, caudal, and posterior portion of anal fin pale or slightly dusky; anterior part of anal fin bluish-black with bright blue anterior margin; pelvic fins blackish with bright blue anterior margin.

*Remarks*: The count of 12 dorsal spines separates *G. springeri* from other known species of *Glyphidodontops*. Most of the members of this genus have 13 spines and at least one other, *G. caeruleolineatus* (Allen), has 14. Specimens of *G. springeri* from Cebu, Philippine Islands tend to have slightly higher gill raker and lateral-line scale counts in comparison with those from the Moluccas (Table 1). *G. springeri* belongs

to a complex which includes *G. azurepunctatus* (Fowler and Bean), *G. hemicyaneus* (Weber), *G. rollandi* (Whitley), *G. talboti* Allen, and *G. traceyi* (Woods and Schultz). These species share a similar dentition and have relatively low soft dorsal, anal, and pectoral counts. They are relatively deep bodied or ovate shaped *Glyphidodontops* and the dorsal profile is distinctive with the membranes between the spines (at least anterior ones) deeply incised. The closest relative of *G. springeri* is *G. hemicyaneus*, differing only in color pattern and dorsal spine count. The latter species generally possesses a variable amount of bright yellow color on the lower half of the body or frequently on the caudal fin and peduncle. It has the normal *Glyphidodontops* compliment of 13 dorsal spines (62 specimens counted at the Australian Museum, Sydney). *G. hemicyaneus* is known from the Ryukyu Islands, Philippine Islands, East Indies, New Guinea, and the Solomon Islands. Its distribution overlaps that of *G. springeri* in the Molucca Islands (based on specimens at the National Museum of Natural History, collected by V. Springer).

Named *springeri* in honor of Dr. Victor G. Springer, Curator of Fishes, Smithsonian Institution. Dr. Springer and M. Gomon collected the holotype and most of the paratypes. These were kindly lent to the senior author along with many other pomacentrids from the Molucca Islands.

## Literature Cited

Allen, G. R. 1972. The anemonefishes, their classification and biology. T.F.H. Publications, Inc., Neptune, New Jersey. 288 pp., 140 figs.

———. 1975. Damselfishes of the South Seas. T.F.H. Publications, Inc., Neptune, New Jersey. 240 pp.

Bleeker, P. 1877. Mémoire sur les Chromides marins ou Pomacentroides de l'Inde archipélagique. Nat. Verh. Holl. Maatsch., Haarlen 3, Ser. 2(6):1–166.

QH
1
B4X
NH

, No. 32, pp. 351–354 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES
1976

# A NEW HIGH ANDEAN SLOPE SPECIES OF *ELEUTHERODACTYLUS* (AMPHIBIA: LEPTODACTYLIDAE) FROM COLOMBIA AND ECUADOR

By John D. Lynch
*School of Life Sciences, The University of Nebraska, Lincoln*

Since redescribing *Eleutherodactylus glandulosus* (Boulenger) from the Papallacta valley in Napo Prov., Ecuador (Lynch, 1970), specimens of a closely related new species have come to my attention. Through the courtesies of Dr. William E. Duellman, Museum of Natural History, The University of Kansas (KU), and Drs. W. Ronald Heyer and George R. Zug, National Museum of Natural History, (USNM) I have examined 28 specimens of the new species from the high Amazonian slopes of the Andes along the border of Colombia and Ecuador.

**Eleutherodactylus leucopus**, new species

*Holotype*: USNM 197927, an adult male from a series collected at Santa Barbara, Napo Prov., Ecuador, 2590 m, by R. Mullen, M. Olalla, and J. A. Peters, 22 June 1962.

*Paratypes*: USNM 197928–36, topotypes; 21–22 June 1962.

*Diagnosis*: (1) skin of dorsum feebly granulate, that of venter coarsely areolate; no dorsolateral folds or enlarged tubercles; (2) tympanum round, prominent, ⅓–½ eye diameter; (3) snout subacuminate in dorsal view, tip pointed, protruding in lateral profile; (4) upper eyelid slightly narrower than interorbital distance; cranial crests present, not prominent; (5) prevomerine odontophores well elevated, oval to triangular in outline; (6) males with vocal slits and external subgular vocal sac; (7) first finger shorter than second; all digits bearing discs on broad pads; (8) fingers bearing lateral fringes; (9) small ulnar tubercles, antebrachial large, non-conical; (10) heel bearing small, non-conical tubercles; inner tarsal fold ridge-like, extending ⅓–½ length of tarsus; outer tarsal tubercles small, non-conical; (11) two metatarsal tubercles, inner oval, 3–4 times size of non-conical outer; plantar surface areolate;

(12) toes bearing prominent lateral fringes, no webs; toes bearing large pads and discs; (13) dark gray above, venter cream flecked with gray; fingers and toes pale cream; posterior thighs, groin dark gray; (14) adults moderate size, ♂♂ 30.0–37.8 mm, ♀♀ 42.3–44.0 mm SVL.

*E. leucopus* is most similar to and presumably closely related to *E. glandulosus*. *E. glandulosus* is smaller (♂♂ 21.5–26.2, ♀♀ 29.4–38.3 mm SVL); has a rounded snout in dorsal view, truncate in profile; has less prominent lateral fringing; and lacks tubercles on the heel and outer edge of tarsus. *E. leucopus* is markedly bicolored with a dark gray to black dorsum instead of brown to yellow-tan of *E. glandulosus*; *E. glandulosus* does not have markedly pale digits. *E. glandulosus* has dark brown areas in the groin and concealed portion of limbs enclosing large yellow spots—neither feature is seen in *E. leucopus*. I know of no other *Eleutherodactylus* species lacking a dorsal pattern and having the markedly bicolor appearance. Few species have protruding snouts (Fig. 1); among Group II *Eleutherodactylus* the feature also occurs in the small Amazonian species *E. acuminatus* Shreve and *E. paululus* Lynch.

*Description*: Statements listed in the diagnosis are not repeated here unless there is some qualifying condition or variation. Head slightly narrower than body, wider than long, notably flat; head width 35.9–42.0 ($\bar{x} = 39.2$, $N = 28$) per cent SVL; tip of snout extending well beyond lower jaw; snout short, E–N 72.9–102.4 ($\bar{x} = 90.6$, $N = 18$) per cent eye length in males, 91.7–109.5 ($\bar{x} = 100.5$, $N = 10$) in females; nostrils not or only weakly protuberant, directed laterally; canthus rostralis relatively sharp, straight; loreal region weakly concave, sloping abruptly to lips; lips not flared; interorbital space gently furrowed, furrow extending anteriorly onto snout; edges of frontoparietals upturned but cranial crests not prominent; upper eyelid width 77.1–104.3 ($\bar{x} = 90.7$, $N = 28$) per cent IOD; supratympanic fold prominent, obscuring upper edge of tympanum, tympanum separated from eye by distance equal one and one-half tympanic diameters; tympanum size not sexually dimorphic, its length 33.8–50.0 ($\bar{x} = 41.8$, $N = 28$) per cent eye length; choanae round, relatively small, not concealed by palatal shelf of maxillary arch; prevomerine teeth and odontophores present, latter median and posterior to choanae, separated by distance equal to choanal breadth, each bearing a transverse row of 4–8 blunt teeth along posterior edge; tongue slightly longer than wide, posterior one-third not adherent to floor of mouth, posterior edge bearing shallow notch; males with long vocal slits lateral to tongue.

Skin of dorsal surfaces feebly granulate (least so on head, most noticeable on posterior portion of body and limbs); no distinct tubercles on head except for one postrictal tubercle; body lacking ridges or folds other than supratympanic fold; throat, venter, and underside of thighs coarsely areolate; discoidal folds prominent; no enlarged subanal warts; forearms robust; two palmar tubercles, outer one smaller, neither as large as oval thenar tubercle; numerous flat supernumerary palmar tubercles; subarticular tubercles round, non-conical, simple; fingers

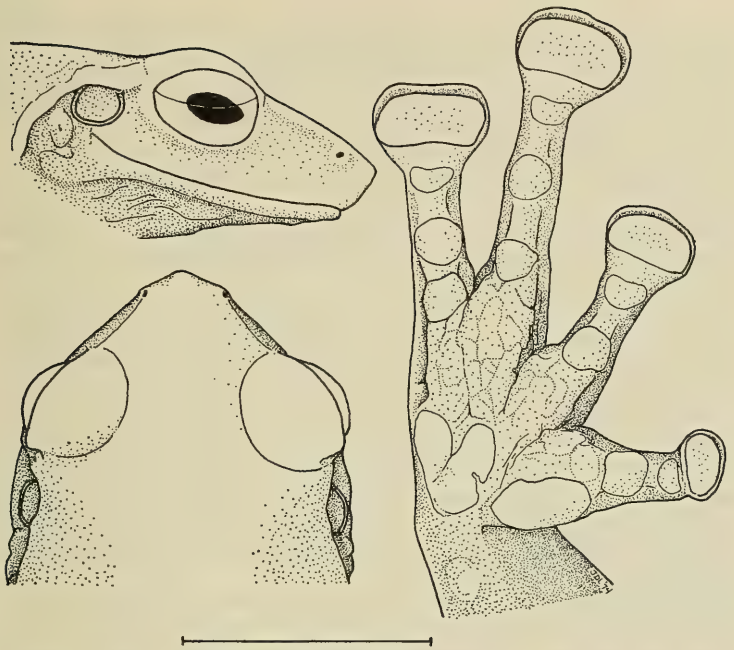


FIG. 1. Head and hand (palmar view) of *Eleutherodactylus leucopus* new species (USNM 197927, holotype). Line equals 10 mm for head, 20 mm for hand.

bearing prominent fringes (Fig. 1), fringes present along outer edge of fingers I and IV as well as outer edge of palm; all fingers bearing discs (broader than long) on large pads; pads round, 2–2½ times digit width below pad except that on thumb which is smaller than pads on fingers II–IV.

Heel bearing one or two small, non-conical tubercles; two metatarsal tubercles, outer longer than wide; inner metatarsal tubercle non-compressed, its length twice its width; many supernumerary plantar tubercles (sole is areolate), all small, flat; subarticular tubercles round, non-conical, simple; toes bearing prominent lateral fringes but lacking distinct webs other than that produced by coalescing lateral fringes; hindlimbs short, heels of legs flexed at right angle to sagittal line just overlap; heel of adpressed hindlimb reaches to between posterior edge of eye and a point between eye and nostril; shank 47.5–56.7 ($\bar{x} = 52.5$, $N = 28$) per cent SVL.

Ground color dark gray; some creamy suffusion on flanks; venter cream with gray flecking; undersides of limbs gray with creamy blotches; posterior surfaces of thighs and groin dark gray; distal por-

tions of fingers and toes pale cream; no bars, bands, or dark spots on dorsal surfaces. The spots in the groin and on the posterior surfaces of the thigh are seen in USNM 197939 (JAP 4589) and 197940 (GOV 8534). The latter has a few spots on the dorsum. Neither is otherwise different from the other specimens examined.

In life, *E. leucopus* was "jet black dorsally, with yellowish white pads and toes." Two individuals were noted as having orange or yellow spots on the thighs.

*Measurements of holotype in mm*: SVL 34.4; shank 17.8; head width 13.6; head length 12.6; upper eyelid width 4.0; IOD 4.4; tympanum length 1.6; eye length 4.1; E–N 3.4.

*Natural history*: No calling males were so noted by the collectors nor were amplectant pairs found. Adults were found at night sitting on leaves and branches in heavy undergrowth in the montane forests. By day, specimens were found beneath logs and other debris in a clearing of good forest. Three adult females were collected. All have extensive convolution of the oviducts and large, yellow ovarian eggs. One adult female was taken in January and the other two in June. The largest immature female (USNM 197937) is 38.5 mm SVL. A slightly smaller female (KU 140306, 37.2 mm SVL) has moderate size eggs and weakly convoluted oviducts. All males examined appear mature (large testes, vocal slits and sacs present).

*E. leucopus* is known from intermediate elevations (2440–2700 m) in the valley of the Rio Chingual at localities in both Colombia and Ecuador. In addition to the holotype and paratypes, the following were examined: COLOMBIA, *Depto. Nariño*: La Victoria, 2700 m, KU 140303–07, 140312. ECUADOR, *Prov. Napo*: Santa Barbara, USNM 197940(7); 1 km NW Santa Barbara, 2590 m, USNM 197938(2); 1 km SW Santa Barbara, 2590 m, USNM 197939(2); 3 km SW Santa Barbara, 2440 m, USNM 197937.

*Etymology*: Greek, meaning white-footed, in reference to the coloration.

*Remarks*: *E. glandulosus* and *E. leucopus* seem to be geminate species. Neither has apparent close relatives on the Andean slopes or paramo and I am aware of no lowland species sufficiently similar to be construed a close relative. The two species are geographically separated by some 120 km of unexplored Andean slopes in Ecuador.

## Literature Cited

Lynch, J. D. 1970. Identity of two Andean *Eleutherodactylus* with the description of a new species (Amphibia: Leptodactylidae). Jour. Herpetol. 3:135–43.

38, No. 33, pp. 355–366 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES FEB 5 1976

# A NEW SPECIES OF *MILVAGO* FROM HISPANIOLA, WITH NOTES ON OTHER FOSSIL CARACARAS FROM THE WEST INDIES (AVES: FALCONIDAE)

By Storrs L. Olson
*Smithsonian Institution, Washington, D.C. 20560*

Extensive collections of vertebrate fossils from caves in Haiti have thus far yielded remains of two extinct birds—a giant barn owl *Tyto ostologa* Wetmore (1922b), and a flightless rail *Nesotrochis steganinos* Olson (1974). In this same material I have recently discovered a single well-preserved and diagnostic bone representing a new species of the falconid genus *Milvago*—a genus hitherto unknown outside of South America and Panamá. Study of this new form has prompted me to investigate the two other fossil caracaras known from the West Indies, *Polyborus latebrosus* Wetmore (1920) of Puerto Rico and *P. creightoni* (Brodkorb, 1959) of the Bahamas.

Within the Falconidae the caracaras form a distinctive group of vulture-like New World falcons, often accorded the status of a subfamily (Polyborinae or Daptriinae) or a tribe (Polybori). Of the other members of the Falconidae, the monotypic Argentine genus *Spiziapteryx* appears to be the closest relative of the caracaras. Its intermediate nature may make it difficult in the future to recognize the caracaras as more than an informal group of the Falconidae (Olson, in press).

Nearly a hundred years ago, Ridgway (1876) reviewed the systematics of the "Polybori" in an excellent and meticulous monograph. Using a wide variety of osteological and external characters, he recognized four genera of caracaras—*Polyborus* (*Caracara* auct.), *Phalcobaenus* (including *Senex*), *Daptrius* (including *Ibycter*), and *Milvago*. These four genera have

been generally recognized, but Vuilleumier (1970) presented a revised classification of the group in which only two genera, *Daptrius* and *Polyborus*, were admitted, the latter encompassing *Phalcobaenus* and *Milvago*. Vuilleumier appears to have overlooked Ridgway's study. He does not consider many of the characters used by Ridgway and as a result his conclusions as to generic limits seem to have a less solid basis than do Ridgway's. For the present I prefer to follow Ridgway in continuing to recognize four genera of caracaras. Because two of these genera, *Daptrius* of neotropical forests and *Phalcobaenus* of the Andes and Patagonia, are not known in the West Indies, they will not be considered here.

### *Milvago* Spix

The genus *Milvago* is composed of two very distinct species. The southern one, *M. chimango*, ranges from southern Brazil and Chile south to Tierra del Fuego. In *M. chimango* the juvenal plumage is similar to that of the adult, the tarsus is long and slender, and the skin about the orbit is feathered. The other species, *M. chimachima*, is found from Panamá and northern and eastern South America east of the Andes, south to northern Argentina, sympatric in the southern parts of its range with *M. chimango*. In *M. chimachima* the adult and juvenal plumages are very different, the tarsus is short, and there is a considerable area of bare skin around the orbit. I agree with Vuilleumier (1970:17) that it is inappropriate to consider these two quite different and partially sympatric species as members of a superspecies, as was suggested by Brown and Amadon (1968). To the two living species we may now add a third, equally distinctive, extinct Antillean form.

**Milvago alexandri**, new species
Figure 1

*Holotype*: Nearly complete right tarsometatarsus, lacking part of the hypotarsal crest and part of the posterior process of the external cotyla,

→

Fig. 1. *Milvago alexandri*, new species, holotype tarsometatarsus, USNM 214573: a, anterior view; b, lateral view; c, posterior view; d, medial view; e, proximal view; f, distal view; a–d stereo pairs, natural size; e and f, twice natural size.

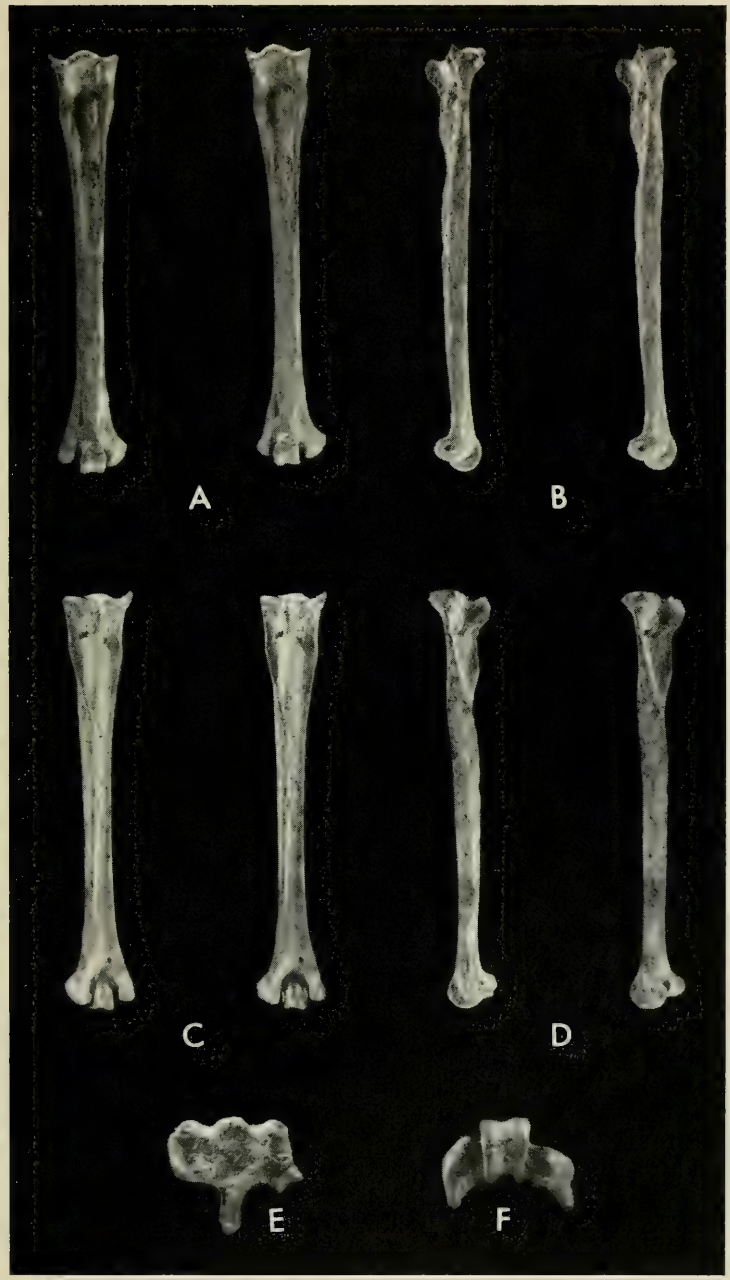

A
B
C
D
E
F

TABLE 1. Length of tarsometatarsus (mm; from skeletons) in three species of *Milvago*.

| | n | range | mean | SD |
|---|---|---|---|---|
| *M. chimachima* | 8 | 49.7–54.5 | 52.3 | 1.49 |
| *M. alexandri* | 1 | —— | 56.2 | —— |
| *M. chimango* | 9 | 57.8–63.9 | 60.1 | 1.88 |

USNM 214573 (Fig. 1). Collected in Pleistocene cave deposits (Cave I in Miller's notes) near St. Michel de L'Atalaye, Département de L'Artibonite, Haiti, Hispaniola, in 1925 by Gerrit S. Miller. The specimen is orange buff in color and was formerly encrusted with reddish limey matrix and old shellac, thus being identical in preservation and preparation to specimens from the older layers of the St. Michel caves.

*Measurements of holotype*: Overall length 56.2 mm, proximal width through anterior portions of cotylae 8.2, depth of internal cotyla 4.3, least width of shaft 3.4, least depth of shaft 2.6, distal width 9.1, depth through arc of trochleae 6.1, width of middle trochlea 3.4.

*Etymology*: I take great pleasure in dedicating this interesting new species to my close friend and associate Alexander Wetmore, in recognition of his many contributions to avian paleontology and to West Indian ornithology, particularly that of Hispaniola.

*Diagnosis and description*: The holotype of *Milvago alexandri* is at once separable from *Polyborus* and *Phalcobaenus* by its much smaller size. From *Daptrius* it may be distinguished by its slender proportions, particularly the narrower proximal end, and by the narrower trochleae, less excavated posterior surface of the proximal end of the shaft and the lower and more elongate tubercle for the tibialis anticus.

In size and proportions the tarsometatarsus of *M. alexandri* is distinctive in being intermediate between the two living species, *M. chimango* and *M. chimachima*. In the last two there is no overlap in the length of the tarsometatarsus of the available skeletal specimens (Table 1). *M. alexandri* differs further from either of the living species as follows: the proximal foramina are larger and more widely spaced; in anterior view the external edge of the shaft bears a more distinct ridge, about as well developed as that of the internal edge, with the result that the anterior face of the shaft appears more deeply excavated; in external view the proximal portion of the external ridge of the shaft is thicker and the papilla for the tendinal attachment on it is better developed; the external trochlea is smaller, projects straight posteriorly rather than curving inward, breaks away more abruptly from the shaft, and has a noticeably deeper pit on the external face; the middle trochlea is proportionately smaller, with a deeper posterior groove.

In the following respects, *M. alexandri* differs from *M. chimango* and more closely resembles *M. chimachima*: shaft more robust; ridge of

hypotarsus extending farther down the shaft; internal cotyla in proximal view not as deep and with posterior border less rounded; wing of inner trochlea much less pronounced and not as distinctly set off from the body of the trochlea.

*Remarks*: Morphologically and geographically, *Milvago alexandri* is closest to *M. chimachima*. There are two possible explanations for its having a longer tarsus than that species. Either *M. alexandri* was derived from *M. chimachima* stock before the two continental species had diverged greatly in tarsal length, or the longer tarsus of *M. alexandri* evolved from the shorter one of *M. chimachima* after the colonization of Hispaniola. Vuilleumier (1970) suggested that a shorter tarsus in caracaras may be correlated with more arboreal habits and noted that the short-legged *M. chimachima* seems to prefer more wooded habitats than the long-legged *M. chimango*. Both species prefer open rather than than densely wooded terrain, and this is about all that can be inferred of the habitat of *M. alexandri*.

The discovery of *M. alexandri* adds a hitherto unknown element to the avifauna of the West Indies. Unless some form of *Milvago* once extended farther north in Central America or through the Lesser Antilles, it must be assumed that *M. alexandri* was derived directly from northern South America.

Although it is probable that the flightless rail *Nesotrochis steganinos* was exterminated by introduced predators, and that the giant barn owl *Tyto ostologa* vanished with the extinction of the large rodents that formed its principal prey, it is not so easy to account for the disappearance of *Milvago alexandri*. Bond (1974) has indicated that Hispaniola is the least known, ornithologically, of the Greater Antilles, thus it is remotely possible that this bird might yet survive there.

### *Polyborus* Vieillot

All the extant forms of the genus *Polyborus* are now considered to belong to a single species, *P. plancus*, which ranges from the southern United States to Tierra del Fuego. The populations of southern South America, *P. p. plancus*, differ from the northern forms in their barred rather than uniformly black dorsum and in their finer ventral barring. The northern forms range from northern South America through Central America to northern Baja California, southern Arizona, and southern Texas. Disjunct populations, probably relicts, are found in south Florida, Cuba and the Isle of Pines, but are not distinguishable from those to the west. The northern forms have at times been divided into three subspecies (*cheriway*, *audubon*, and *ammophilus*) and were long regarded as a species (*cheriway*) distinct from *plancus*. Hellmayr and Conover

(1949) demonstrated that the two "species" intergrade in Brazil and regarded them as races of a single species. For the purposes of the following discussion, the three northern forms will be referred to collectively as *Polyborus plancus cheriway*. The population of the Tres Marías Islands, Mexico, is distinctly smaller and somewhat paler than the mainland forms and is recognized as a separate subspecies, *P. p. pallidus* (Grant, 1965). Of greater interest is the extinct form *P. lutosus* from Guadelupe Island off Baja California, which in its plumage, and to a lesser extent the shape of the rostrum, is quite distinct. Vuilleumier (1970) regarded *P. lutosus* as a subspecies of *P. plancus*, but most authors have accorded it full specific rank. What is most interesting about *P. lutosus* is that its plumage pattern is more similar to the South American race *P. p. plancus* than to the race of the adjacent mainland.

Wetmore (1920, 1922a) described a new species of caracara, *Polyborus latebrosus*, from Pleistocene cave deposits in Puerto Rico, based on the proximal end of a right carpometacarpus (holotype) and the proximal end of a right ulna. It was said to be intermediate between *P. cheriway* and *P. plancus* (then considered separate species) but distinct from either.

Howard (1938) analyzed the abundant caracara remains from the Pleistocene tar pits at Rancho la Brea in southern California and concluded that they represented an undescribed species which she named *Polyborus prelutosus*. In her studies, *P. plancus* and *P. cheriway* were regarded as distinct species and *P. prelutosus*, like *P. latebrosus*, was said to exhibit characters intermediate between the two forms and others in which it was more similar to *P. plancus*. Howard concluded that *P. plancus*, *P. lutosus*, *P. prelutosus*, and *P. latebrosus*, were more primitive and more closely related to each other than any were to *P. cheriway*, which was presumed to have replaced the more primitive forms in the areas where it presently occurs. I am basically in agreement with this conclusion, my main reservation being the level at which the taxa are to be recognized. Howard stated (1938:239) that *P. prelutosus* undoubtedly "represents a form not far removed from, if not actually the ancestral type of, the Recent caracaras," but she rejected the idea of its being a temporal subspecies on the

grounds that temporal variation "cannot be evaluated in the same manner as intergradation of contemporaneous geographic races." Pleistocene remains of caracaras from New Mexico and Florida, previously referred to *P. cheriway*, were reidentified as *P. prelutosus* by Howard (1938). Records of *P. prelutosus* from other localities, including Texas, are listed by Brodkorb (1964). A series of specimens of *P. prelutosus* from San Josecito Cave, Nuevo Leon, Mexico, was found to average smaller than the series from Rancho La Brea, some specimens being smaller than the minimum for that locality. Although there was broad overlap in measurements, Howard (1940) designated the Mexican bones as a new subspecies, *Polyborus prelutosus grinnelli.*

From a Pleistocene deposit on New Providence Island, Bahamas, Brodkorb (1959) described yet another species, *Caracara* (= *Polyborus*) *creightoni.* This was based entirely on a fragmentary distal portion of a left carpometacarpus consisting mostly of the second metacarpal.

I have studied the type-material of *Polyborus latebrosus* and *P. creightoni.* Comparisons were made with 7 skeletons of *P. plancus plancus*, 11 of *P. p. cheriway*, 1 of *P. lutosus*, and 10 carpometacarpi of *P. prelutosus.* It must be emphasized that within the modern and fossil series there is a very great deal of individual variation in size, in proportions, and in the conformation of minor features of the bones.

The holotype carpometacarpus of *P. latebrosus* was said to be slightly larger than in *P. p. cheriway* (Wetmore, 1922a). As shown by Howard (1938), who also studied the type, the bone is near the maximum or slightly larger than in *P. p. cheriway* but falls well within the range of *P. p. plancus* and *P. prelutosus.* The referred ulna of *P. latebrosus* was described by Wetmore (1922a) as being larger than in *P. cheriway* but smaller than in *P. plancus.* In reality, however, it is matched only by smaller specimens of *P. cheriway.* In view of the seeming discrepancy between the size of the ulna and that of the carpometacarpus of *P. latebrosus*, it may be worth noting that Howard (1938) found the carpometacarpus of *P. prelutosus* to be proportionately larger than would be expected from the size of the other elements. The supposed distinctions

in the type of *P. latebrosus* are very minor features, most of which are highly variable in modern forms. The variation in the shape of the first metacarpal, for instance, is so great in the comparative series that given the same level of criteria as used to differentiate *P. latebrosus* it would be possible to name nearly each specimen as a different species. In her comparisons, Howard (1938:225) commented that "*latebrosus* reveals marked overlapping similarities" with *P. prelutosus*. The only distinguishing feature of *P. latebrosus* was said to be in the "unusual position of the notch between the process of metacarpal 1 and the trochlea," which was said to be at the junction of those two features rather than anterior to that junction. This was deemed sufficient to separate "*latebrosus* from the Rancho La Brea bird as well as from all the other species" (Howard 1938:225). Wetmore (1922a:305) also mentions a "notch at the outer margin of the proximal condyle [being] lower so that it is found at the line of ankylosis of the first and second metacarpals instead of above that point." Even after prolonged scrutiny of the type, the feature was not apparent to me and the distinction would seem to be a very minor one.

It is difficult not to doubt the validity of *Polyborus creightoni* solely on the basis of its being based on such a fragmentary specimen almost wholly lacking in diagnostic features. Nevertheless, it cannot, in fact, be summarily dismissed. Because the type is so imperfect, it occurred to me that it might be from some bird quite unrelated to *Polyborus*, but on comparison no more suitable placement for it could be found. In contrast to the type of *P. latebrosus*, the type of *P. creightoni* is small. Although it falls within the size range of *P. p. cheriway*, only one of the specimens examined was smaller, this being number 28302 in Dr. Brodkorb's collection (distance from distal end of metacarpal II to metacarpal I = 42.9 mm as opposed to 43.8 mm in *P. creightoni*). In two of the characters given by Brodkorb (1959), *P. creightoni* does appear to be distinct; the other differences cited do not stand up on comparison with the series of *Polyborus* at hand. These two characters are: "metacarpal III with its base nearly straight, without medial angulation proximal to intermetacarpal tuberosity; tuberosity of metacarpal II, in medial view, with its

outline more angular and less rounded, and its base more deeply excavated dorsally and laterally" (Brodkorb, 1959: 353). It is difficult to determine just how much consideration should be given to such minor differences.

The only fossil form of *Polyborus* for which there is adequate material to make any determination of its status is *P. prelutosus*. Howard (1938) has demonstrated that this form is not identical with its geographically nearest modern congeners. Yet when *P. cheriway* and *P. plancus* are combined, virtually all of the variation seen in *P. prelutosus* falls within the range of the expanded species *P. plancus*. It appears that only in its smaller and proportionately wider bill is *P. prelutosus* recognizably different from *P. plancus* and in this respect it resembles *P. lutosus* of Guadelupe.

I do not consider that an adequate basis exists for regarding any of the named fossil forms of *Polyborus* as being specifically distinct from *P. plancus*, particularly given the great variability of that species. *P. prelutosus* is almost surely the temporal equivalent of, and on a direct genetic line with, *P. plancus*. The present status of the West Indian forms *P. latebrosus* and *P. creightoni* seems unsatisfactory when one recognizes that both geographic as well as temporal variation may be involved. I believe it is best to regard all the known fossils of *Polyborus* as belonging to the species *plancus*. Within that species, *prelutosus* is a valid temporal form. The names *creightoni* and *latebrosus* are available if further material should indicate that either of the populations they represent are subspecifically distinct, although the possibility exists that such material might show *latebrosus* to be inseparable from *prelutosus*.

## Acknowledgments

For the loan of types and comparative material I am greatly indebted to Malcolm C. McKenna, American Museum of Natural History; S. David Webb and Pierce Brodkorb, University of Florida; Robert McKenzie and David P. Whistler, Natural History Museum of Los Angeles County. I am likewise grateful to G. B. Sullivan for his preparation of the type of *M. alexandri* and to Victor E. Krantz for photographing it. For their useful comments on the manuscript I thank Isabel Canet,

Robert J. Emry, John Farrand, Jr., Larry D. Martin, Clayton E. Ray, and Alexander Wetmore.

Resumen

Se describe una nueva especie de caraira (Falconidae), *Milvago alexandri*, encontrada en depósitos pleistocénicos de la Española. El género *Milvago* hasta ahora se conocía sólo de América del Sur y Panamá, por tanto la especie *M. alexandri* representa un elemento completamente nuevo para la fauna antillana. Otras dos especies fósiles de carairas antillanas, *Polyborus latebrosus* Wetmore de Puerto Rico y *P. creightoni* (Brodkorb) de las Bahamas, no fueron descritas en base de restos suficientes de modo que puedan ser distinguidas de la especie viviente *P. plancus*. Aquí consideramos que pueden ser sólo subespecies de *P. plancus*.

Literature Cited

Bond, J. 1974. Nineteenth supplement to the Check-list of Birds of the West Indies (1956). Acad. Nat. Sci. Philadelphia.

Brodkorb, P. 1959. Pleistocene birds from New Providence Island, Bahamas. Bull. Fla. State Mus. Biol. Sci. 4:349–371.

———. 1964. Catalogue of fossil birds: Part 2 (Anseriformes through Galliformes). Bull. Fla. State Mus. Biol. Sci. 8:195–335.

Brown, L. and D. Amadon. 1968. Eagles, hawks and falcons of the world. New York, McGraw-Hill. 2 vols.

Grant, P. R. 1965. A systematic study of the terrestrial birds of Tres Marias Islands, Mexico. Postilla 90:1–106.

Hellmayr, C. E. and B. Conover. 1949. Catalogue of birds of the Americas. Zool. Ser. Field Mus. Nat. Hist. 13 (Pt. 1, No. 4): 1–358.

Howard, H. 1938. The Rancho La Brea caracara: a new species. Carnegie Inst. Wash. Publ. 487:217–240.

———. 1940. A new race of caracara from the Pleistocene of Mexico. Condor 42:41–44.

Olson, S. L. 1974. A new species of *Nesotrochis* from Hispaniola, with notes on other fossil rails from the West Indies (Aves: Rallidae). Proc. Biol. Soc. Wash. 87:439–450.

———. in press. The affinities of the falconid genus *Spiziapteryx*. Auk.

Ridgway, R. 1876. Studies of the American Falconidae. Monograph of the Polybori. Bull. Geol. Geogr. Surv. Terr. Ser. 2, 6:451–473.

Vuilleumier, F. 1970. Generic relations and speciation patterns in the caracaras (Aves: Falconidae). Breviora 355:1–29.

Wetmore, A. 1920. Five new species of birds from cave deposits in Porto Rico. Proc. Biol. Soc. Wash. 33:77–82.

———. 1922a. Bird remains from the caves of Porto Rico. Bull. Amer. Mus. Nat. Hist. 46:297–333.

———. 1922b. Remains of birds from caves in the Republic of Haiti. Smithson. Misc. Collect. 74(4):1–4.

, No. 34, pp. 367–372 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# A NEW SPECIES OF *SPHAERODACTYLUS* (SAURIA: GEKKONIDAE) FROM HISPANIOLA

By Albert Schwartz and Richard Franz
*Miami-Dade Community College North,*
*Miami, Florida 33167, and*
*Florida State Museum, University of Florida,*
*Gainesville, Florida 32611*

LIBRARIES 1976

Among the Hispaniolan species of *Sphaerodactylus, Sphaerodactylus copei* Steindachner is one of the most distinctive. It reaches a snout-vent length of 42 mm; has very much enlarged and almost boss-like dorsal scales in contrast to much smaller, smooth ventral scales; a middorsal zone of tiny granules; and four supralabial scales to the center of the eye. The females are brightly patterned in contrast to generally more drab and unpatterned males (Schwartz, 1975). Nine subspecies of *S. copei* are now recognized. The species is restricted to the Haitian Tiburon Peninsula and to Ile de le Gonâve, Ile Grande Caymite, and Ile-à-Vache. *S. copei* has never been recorded from the República Dominicana (where it is expected in the Valle de Neiba, the eastern extension of the intermontane arid Cul de Sac Plain) despite having been taken within a very few kilometers of the Dominico-Haitian border (near Fond Parisien in the Cul de Sac Plain, Haiti). Although widely distributed on the Tiburon Peninsula, large areas still remain whence *S. copei* is unknown.

The Península de Barahona and the associated southern foothills of the Sierra de Baoruco and the Massif de la Selle which border the xeric lowlands of the peninsula in the República Dominicana on the north have been revealing an interesting array of herpetological species which are limited to, or have their centers of distribution in, this arid region. This is surely

in part due to the fact that these lowlands are completely cut off in the north from other arid areas by the very mesic Sierra de Baoruco which reaches the shore along the east coast of the peninsula. Thus, animals on the Península de Barahona are "trapped" in and severed from their more northern relatives by the intervening massif of the Sierra de Baoruco; this "Barahona Entrapment" has played a significant role in the evolution of the amphibians and reptiles of the Península de Barahona, where such species as *Eleutherodactylus alcoae* Schwartz, *Leptotyphlops pyrites* Thomas, *Typhlops syntherus* Thomas, *Anolis longitibialis* Noble and *Ameiva leberi* Schwartz and Klinikowski are localized. A host of other reptiles, including amphisbaenids, lizards, and snakes, have subspecies which are endemic to this region.

The *Sphaerodactylus* of the Península de Barahona are poorly known. *S. difficilis randi* Shreve has been collected at Oviedo and its vicinity near the eastern coast of the peninsula, and at and near Pedernales on the Dominico-Haitian border on the west. A second unnamed species, with primarily Haitian distribution, crosses the border and occurs at Pedernales and in the Sierra de Baoruco at low to intermediate elevations. The high uplands of the Sierra de Baoruco are occupied by *S. armstrongi* Noble and Hassler. No *Sphaerodactylus* are known from the lowlands of the Península de Barahona between Oviedo in the east and Pedernales in the west, although the 65 kilometer distance between these two extremes seems eminently suitable for members of this genus. In the east, the peninsula was originally covered with fairly high canopied xeric forest on a rocky substrate; this forest was virtually destroyed by Hurricane Inez in 1966. Farther west, at about mid-peninsula, the road gradually ascends a forested limestone ridge; its western escarpment is steep and borders the very hot and dry plain on which Pedernales is situated in the westernmost corner. Much of the latter plain, as well as the limestone ridge, is rocky or rock-strewn and provides a suitable habitat for *Sphaerodactylus*. These same conditions persist onto the southern slopes of the Massif de la Selle above Pedernales and the Sierra de Baoruco above Cabo Rojo, but in both cases, despite often intensive search

and the taking of other cryptic or burrowing reptiles, no sphaerodactyls have been secured.

Between 20 and 24 March 1974, the junior author, with Sylvia Scudder and Fred G. Thompson of the Florida state Museum, collected in the region between Cabo Rojo and Pedernales. Their collections include two specimens of a new species of *Sphaerodactylus*, one of which is from the xeric lowlands of the Península de Barahona and the other from low elevations on the southern Sierra de Baoruco slopes. This new species is allied to the Haitian S. *copei*; the latter species (subspecies *enochrus* Schwartz and Thomas) occurs in southeastern Haiti from southwest of Jacmel and the Vallée de Trouin, east to the vicinity of Marigot, about 60 kilometers west of the Dominico-Haitian border. Thus there is a hiatus of about 75 kilometers between the known distributions of S. *copei* and the new species; since the extreme southeastern portion of Haiti remains unknown as far as sphaerodactyls are concerned, it is likely that one or the other species will be collected at Saltrou, Grand Gosier, or Anse-à-Pitre, all along the southeastern Haitian littoral. Although the new species is allied to *S. copei*, it differs in several trenchant characters and we have no doubt that it represents still another Península de Barahona endemic, derived from more western *S. copei*. For this new species, in honor of Dr. Thompson whose efforts were responsible for securing the two known specimens, we propose the name

**Sphaerodactylus thompsoni**, new species

*Holotype*: UF/FSM (Florida State Museum, University of Florida) 21555, adult female, from 6 km SW Las Mercedes, 60 m, Pedernales Province, República Dominicana, taken 21 March 1974 by Fred G. Thompson. Original number FGT 1777.

*Paratype*: UF/FSM 21556, 11 km N, 2 km SE Cabo Rojo, Pedernales Province, República Dominicana, 23 March 1974, F. G. Thompson.

*Diagnosis*: A large species of *Sphaerodactylus* (snout-vent length 33 mm) with large keeled boss-like dorsal scales (17–18 between axilla and groin); small cycloid smooth ventral scales (32–33 between axilla and groin); no middorsal rows of small granular scales; females (only sex known) pale drab grayish above with complex head pattern (see illustrations), without dark collar and included ocelli or dark body bands with included ocelli, but with (in juveniles and very vaguely indicated in adults) three fine transverse black lines between axilla and groin,

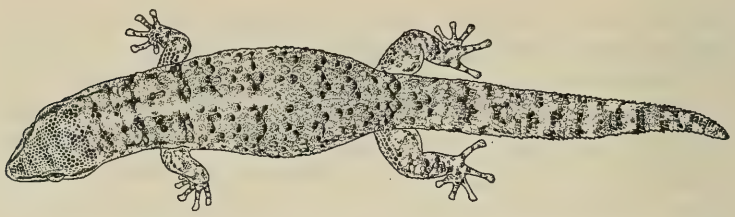


FIG. 1. *Sphaerodactylus thompsoni*, holotype, UF/FSM 21555, dorsal view.

anteriormost of these broadest and more or less attached to complex drak cephalic pattern.

*Description of holotype*: Dorsum (as preserved; not strongly different from life condition) very pale grayish or tan with dark brown head and body markings as follows. Head with median dark attenuate triangle on snout, its base anterior to eyes; dark canthal line extending through eye and auricular opening, with dark spot following it; dark marbling on upper lip, including dark spot below auricular opening; a transversely elongate hollow rectangle, its anterior side between posterior portions of eyes, its posterior margin at about level of mid-temple; another vague dark line connecting anterior corners of eyes; upper surface of neck with five brown spots (two lateral pairs and a median elongate blotch) followed by two transversely elongate markings, these in turn by an incomplete dark line across neck (the last three features all more or less united to and by dark dorso-lateral line which is the continuation of canthal-postocular line and blotch); very irregular and broken transverse line above forelimb insertions; remainder of dorsum with scattered dark scales that do not form a recognizable pattern; upper surfaces of all limbs and tail dotted with dark brown scales, those of tail forming a series of vaguely delimited rings which continue irregularly on underside of tail and are more complete distally; throat vaguely stippled with dark gray. Measurements and counts from holotype are: snout-vent length 33 mm; 17 large keeled boss-like dorsal scales between axilla and groin, 38 scales around body at midbody, 11 fourth toe lamellae, 2 internasal scales; 4/4 supralabial scales to mid-eye.

*Variation*: The paratype is a juvenile with snout-vent length of 19 mm, 17 dorsal and 38 ventral scales between axilla and groin, 38 scales around body at midbody, 10 fourth toe lamellae, 1 internasal, and 4/4 supralabials to mid-eye. Head pattern much as described for holotype except pre- and post-forelimb dorsal crossbands more clearly delimited, less fragmented and darker than all other markings on body, which in holotype speckled with dark scattered scales. Distinct dark crossband above hindlimb insertion. Tail has six pale grayish rings (becoming white distally) alternating with dark gray rings (becoming more complete ventrally distally); these dark rings somewhat paler centrally to

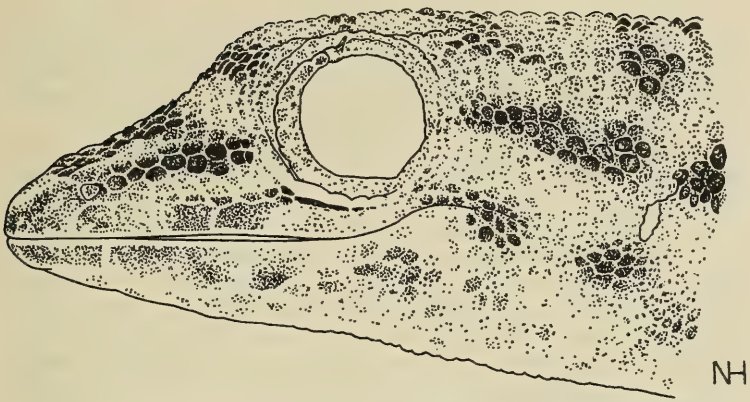



FIG. 2. *Sphaerodactylus thompsoni*, holotype, UF/FSM 21555, lateral view of head.

give series of dark gray edges bordering pale gray to white rings; tail tip black; some fine dark stippling on throat.

*Comparisons*: Comparisons of *S. thompsoni* wih any species other than *S. copei* are unnecessary; the large boss-like and keeled dorsal scales immediately distinguish *S. thompsoni* from all other species in Hispaniola. From *S. copei*, the absence of a middorsal zone of small scales or granules distinguishes *S. thompsoni*. It is in pattern (and probably in coloration in life) also that the two species are radically different. Thomas (1968:fig. 2d) showed a dorsal view of *S. c. enochrus*. The head in that subspecies includes three pale lines on an otherwise dark brown ground, followed by two rows of subcircular or oval pale dots, followed by a dark collar with included pale ocelli. The body has two or three (usually two) dark crossbands with included pale ocelli in juveniles, but this pattern becomes, in adult females, a random series of dark and pale scattered scales on a medium dark (brown) ground. Considering the illustrations of the other subspecies (Thomas, 1968) as well as the verbal descriptions of subspecies subsequently named (Schwartz, 1975), one can see that no other population of *S. copei* approaches *S. thompsoni* in complete reduction of dark collar and included ocelli (although the ocelli may be present but not in a dark collar); in addition, the fine dark isolated juvenile crossbands in *S. thompsoni* differ strongly from the broad crossbands with their included ocelli in *S. copei*.

None of the meristic characteristics of *S. thompsoni* differentiates the species from *S. copei enochrus*. In 33 specimens of *S. c. enochrus* examined, the largest female has a snout-vent length of 39 mm, larger than the single adult female *S. thompsoni*. Dorsals in axilla to groin distance are 13–18 in *S. c. enochrus*, 17–18 in *S. thompsoni*; ventrals in the same distance are 23–31 in *S. c. enochrus*, 32–33 in *S. thompsoni*;

midbody scales in *S. c. enochrus* are 38–45 and 38 in both specimens of *S. thompsoni*. No *S. c. enochrus* has 2 internasals (although this condition occurs in two subspecies (*picturatus* Garman, *websteri* Schwartz), whereas one of two *S. thompsoni* has 2 internasals. Both taxa normally have 4 supralabials to the center of the eye.

*Remarks*: The holotype was taken under rocks near the top of a small talus cone, about 12 feet (3.7 m) above the base. The cone consisted of loosely packed limestone rocks up to 2 feet (0.6 m) in diameter and covered lightly with dry leaves. The cone was located against one wall of a rather steep-sided ravine or wash, the floor of which was made up of fine sediments and some cobble. The opposite wall consisted of ledges of limestone with shallow dry caves occupied by *Cyclura*. The vegetational cover was sub-mesic in the ravine with xeric conditions (*Agave*, *Acacia*, cacti) on the upper slopes and surrounding hillsides. There are no further data on the collection site of the paratype. We assume that *S. thompsoni* is widely distributed on the Península de Barahona. The habitat noted above is widespread and rocky and talus cover are commonplace throughout the area. It is truly remarkable, despite intensive collecting in this region since 1963, that the species has not been previously collected. Since Dr. Thompson was collecting living snails in this xeric region, he made a point of disturbing and tearing apart talus and rubble piles; this activity may have been responsible for taking of the two specimens, since mere rock turning has repeatedly yielded no sphaerodactylus on the peninsula. In those areas where other species of *Sphaerodactylus* have been locally taken (Oviedo; Pedernales; and their vicinities) the ecology is regularly less harsh, more shaded, and somewhat more mesic than in those rigorous localities whence *S. thompsoni* has been collected.

## Acknowledgments

We wish to thank Dr. Fred G. Thompson for allowing us to describe this distinctive new species, and Nancy Halliday, the staff artist at the Florida State Museum, for her beautiful illustrative work. Comparative specimens of *S. c. enochrus* in the collection of the senior author were taken through the efforts of James W. Norton, William W. Sommer and Richard Thomas.

## Literature Cited

Thomas, R. 1968. Notes on Antillean geckos (*Sphaerodactylus*). Herpetologica 24(1):46–60, Figs. 1–4.

Schwartz, A. 1975. New subspecies of *Sphaerodactylus copei* Steindachner (Sauria, Gekkonidae) from Hispaniola. Herpetologica 31(1):1–18.

88, No. 35, pp. 373–382 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES 1976

# TWO NEW DIPLOPODS OF THE GENUS *POLYZONIUM* FROM NORTH CAROLINA, WITH RECORDS OF ESTABLISHED SPECIES (POLYZONIIDA: POLYZONIIDAE)

By Rowland M. Shelley
*North Carolina State Museum, P. O. Box 27647, Raleigh, North Carolina 27611*

Millipeds of the genus *Polyzonium* are common in the litter fauna of eastern North America. The small, yellowish animals are easily recognized as *Polyzonium*, but until the recent summary by Loomis (1971), assignment to species had been on an indiscriminate basis. Loomis recognized eight species in North America, two of which, *P. bivirgatum* and *P. rosalbum*, have been reported from several North Carolina localities (Causey, 1940; Wray, 1967; Loomis, 1944, 1971). Unfortunately, these records are rather confused, especially for the piedmont, and in a few cases both names appear to have been assigned to the same material. In addition, the polyzoniid fauna of North Carolina is considerably more complex than previously thought, with at least two additional species, both undescribed, occuring in the state.

Reviewing the published North Carolina records in light of the criteria established by Loomis (1971), it becomes readily apparent that a number must be discounted until confirmed by fresh material. Some listings are based on representatives of the two new species, while others cannot be verified due to absence of the specimens. For all practical purposes, it is necessary to discard the previous North Carolina records of *Polyzonium* and start over. Furthermore, an additional barrier exists to resolution of this problem—the identity of *Buotus carolinus*, proposed by Chamberlin (1940) for an immature female polyzoniid from Duke Forest. The type

and only known specimen was deposited in the Chamberlin collection and is currently unavailable. The description is vague and unillustrated but suggests that the specimen might be of the genus *Polyzonium.* Establishing the specific identity of *B. carolinus* will be difficult because the type specimen lacks gonopods, but it may eventually be shown to be an undescribed species of *Polyzonium* in which the distal podomere* of the anterior gonopods is straight and not apically curved. For this form, the dominant polyzoniid in the eastern piedmont, I propose the name *Polyzonium strictum.* If *B. carolinus* should prove to be this form, its specific name will have priority and that of the former will become a junior synonym. Description of this form has been deferred because of the *Buotus* situation, but a name must now be established for use in future studies on North Carolina diplopods.

A series of papers is eventually planned on the milliped genera of North Carolina. Many regions remain to be collected, however, and these studies are several years from completion. In view of the current confusion on *Polyzonium,* it seems that an interim report on the genus is desirable, in order to identify the species known from the state and to report authentic localities. This paper is submitted for that purpose. Descriptions and illustrations of the two new species are included along with figures of the anterior gonopods of *P. bivirgatum* and *P. rosalbum.* Individuals are most accurately identified by comparing the anterior gonopods of males with these drawings. Hopefully, this paper will clarify the status of North Carolina polyzoniids until a more thorough study can be prepared.

Lines of affinity in the genus *Polyzonium* are virtually impossible to determine due to our poor knowledge of most of the species. Loomis (1971) did not discuss relationships in his paper, which is the best available on the American forms. Thus, only very tentative conclusions can be drawn about the relationships of the two new species described herein. A real monograph of the genus, addressing problems of phylogeny, is clearly to be desired.

---

* The term "distal podomere" is used in this paper in the same sense as "seminal joint" by Loomis (1971).

I am grateful to H. F. Loomis for his valuable advice and to Richard L. Hoffman for the loan of his *Polyzonium* collection. Material from Hanging Rock, Morrow Mountain, and William B. Umstead State Parks was collected with permission of the North Carolina Department of Natural and Economic Resources, Division of State Parks. The specimens listed below are deposited in either the personal collection of Richard L. Hoffman (RLH) or the invertebrate collection of the North Carolina State Museum (NCSM).

**Polyzonium strictum**, new species
Figures 1–4

*Type-specimens*: Male holotype (NCSM 1881) and 7 male and 6 female paratypes collected by the author, 25 July 1973, from Wilkes County, North Carolina, 4.4 miles NE McGrady, along county road 1730, 0.2 miles N junction county road 1728. Paratypes deposited in the U.S. National Museum; the Florida Collection of Arthropods, Gainesville; and the Zoologische Museum Amsterdam.

*Diagnosis*: Distal podomere of anterior gonopods apically straight, blunt, not curved mediad or laterad; sternal lobes low, moderately separated, base and tip subequal in width. Similar in size, general appearance, and sternal lobes of anterior gonopods to *P. rosalbum*, with which it may occur sympatrically (probably not syntopically), but differing in configuration of distal podomere of anterior gonopods and in much thinner first two legs.

*Holotype*: Length 9.5 mm, width 2.0 mm, 46 segments. Color yellowish, lighter on edges, posterior segments, and venter; dorsum with two rows of slightly darker, paramedian spots, one pair per segment, running entire length of specimen. Collum large, hood-like, completely covering ocelli and first two antennomeres. Sides of head slightly concave, meeting in front in angle of about 75°; antennae extending well beyond sides of body when held laterally; ocelli 3–3, equidistant, second ocelli larger than others, anterior interocular space subequal to diameter of ocellus, posterior interocular space 4–5 times as wide. Pores of segment 5 (Fig. 2) lower than those that follow, sides raised, interzonal stria only slightly bulging behind pores. Ultimate segment evenly rounded.

Anterior gonopods (Fig. 1) with sternal lobes short and broad, moderately separated; coxal lobe broad, slightly curved mediad at midlength but not apically, broad and rounded at tip; distal podomere slightly bulging at base, slightly curved mediad at midlength, but apex straight and blunt, not curved mediad or laterad. Legs 1 and 2 (Figs. 3, 4) smaller and thinner than succeeding ones, leg 3 slightly thickened. Sterna on legs 1 and 2 low and narrow, coxae almost touching; coxae of leg 3 more separated; sterna on other pregonopodal legs broad and low,

coxae well separated; sterna on postgonopodal legs low and narrow, coxae almost touching.

*Variation*: The male paratypes agree with the holotype but have fewer segments. The female paratypes are generally darker, with brown speckles on the anterior segments. The collum of the females appears smaller than that of the males, and all sterna of the females are low and narrow, with the coxae almost touching, On the other males, the size of the collum varies, and on some individuals it does not completely cover the ocelli. All mature individuals have three pairs of ocelli; one immature male from Durham Co. has two pairs. The gonopods are quite consistent, with the distal podomere always being straight, never apically curved. The size of the bulge at the base of the distal podomere varies in relation to the angle at which the distal podomere is directed. This structure is not always perpendicular but may lean slightly mediad or laterad, and those individuals in which the distal podomere leans laterad have a greater basal bulge.

*Ecology*: *Polyzonium strictum* is usually encountered in moist humus under or near rocks or logs in predominantly hardwood regions. It may occasionally be found under the bark of decaying pine logs.

*Distribution*: The species is known from Virginia and North Carolina, where it ranges from the mountains to the inner coastal plain. It has not yet been collected in Tennessee, South Carolina, or most of the coastal plain of North Carolina, but this absence is undoubtedly due to lack of investigations in these areas. Specimens have been examined as follows:

Virginia: Pulaski Co., Draper Mtn. above Pulaski, 1♂, 2♀, 4 October 1959, R. L. Hoffman and R. E. Crabill (RLH).

North Carolina: Madison Co., ravine along Southern railroad between Hot Springs and Paint Rock, 1♂, 2 August 1962, R. L. Hoffman (RLH). Ashe Co., 7.2 miles SE Jefferson, 1♂, 6♀, 21 June 1972, R. M. Shelley (NCSM 1200). Wilkes Co., 4.4 miles NE McGrady along co. rd. 1730, 0.2 miles N jct. co. rd. 1728, 8♂, 6♀, 25 July 1973, R. M. Shelley (NCSM 1881) TYPE LOCALITY; and 9 miles SE Wilkesboro, 2♂, 2♀, 26 July 1973, R. M. Shelley (NCSM 1827). Stokes Co., Hanging Rock State Park, 2♂, 4♀, 30 May 1973, R. M. Shelley (NCSM 1800). Stanly Co., 3 miles SE Albemarle, 4♂, 1♀, 19 October 1952, L. Hubricht (RLH); and Morrow Mtn. State Park, 1♂, 4♀, 9 August 1973, R. M. Shelley (NCSM 1901). Montgomery Co., 12 miles NW Troy, 2♂, 8♀, 19 July 1952, R. M. Shelley (NCSM 1175). Randolph Co., 7.2 miles NW Asheboro, 3♂, 15 juvs., 11 May 1972, R. M. Shelley (NCSM 1047). Caswell Co., 2.4 miles SE Yanceyville, 1♂, 23 May 1973, R. M. Shelley (NCSM 1779). Vance Co., 4.6 miles N Henderson, 1♂, 2♀, 25 August 1972, R. M. Shelley (NCSM 1500). Durham Co., 14.1 miles N Durham, 5♂, 12♀, 11 August 1972, R. M. Shelley (NCSM 1470). Orange Co., 1.5 miles SSW Hillsborough, 2♂, 2♀, 2 August 1973, R. M. Shelley (NCSM 1886). Wake Co., William B. Umstead State Park, 4♂, 9♀, 11 October 1971, R. M. Shelley (NCSM 2263);

and 4 miles SW Cary, Hemlock Bluffs, 2♂, 2♀, 17 June 1975, J. C. Clamp (NCSM A1) and 1♂, 4♀, 16 June 1975, J. C. Clamp (NCSM A2). Lee Co., 10 miles NE Sanford, 5♂, 10♀, 28 May 1974, R. M. Shelley (NCSM 1516). Moore Co., High Falls, 1♂, 28 August 1974, R. M. Shelley (NCSM 2501); and 8.6 miles W Carthage, 1♂, 2♀, 5 July 1974, R. M. Shelley (NCSM 2355). Cumberland Co., Fayetteville, 2♂, 2 juvs., 22 November 1948, D. L. Wray (RLH); and 2♂, 3♀, 24 October 1974, P. D. Kinser (NCSM 2774).

*Remarks*: *Polyzonium strictum* is the dominant polyzoniid diplopod in the eastern piedmont of North Carolina. It has been found sympatrically with *P. rosalbum* in Pulaski Co., Virginia, and Madison and Moore (High Falls) Cos., North Carolina, but the two species are probably not syntopic. In view of the morphological similarities between these two species, a close phylogenetic relationship is suspected.

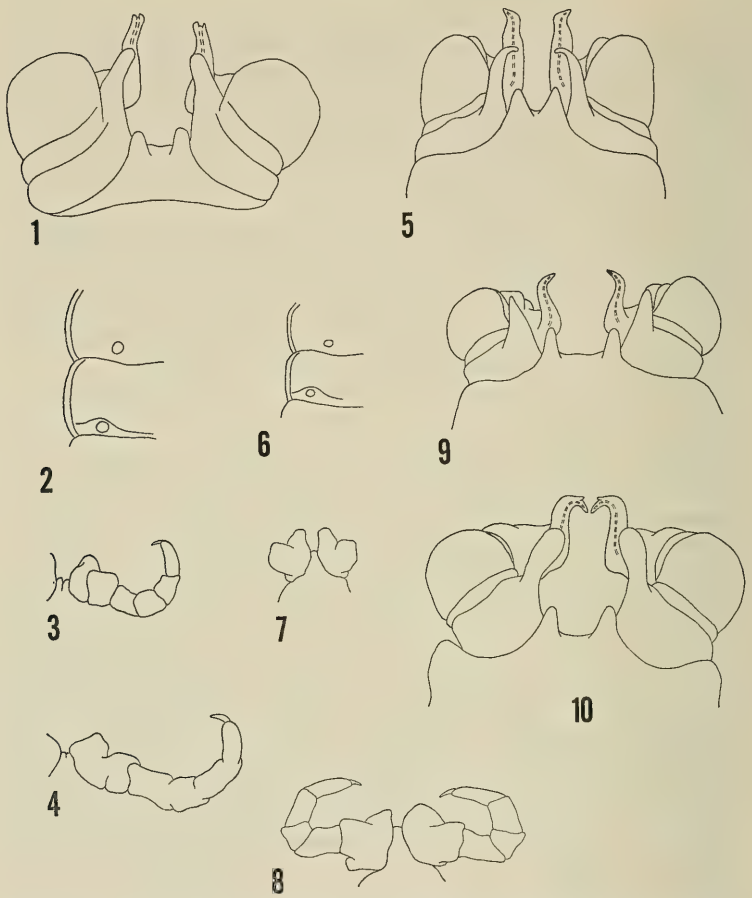
Previous records of *Polyzonium* from piedmont North Carolina include *P. bivirgatum* from Durham (Loomis, 1944; Wray, 1967); Duke Forest (Wray, 1967); and Fayetteville, Cumberland Co. (Wray, 1967). *Polyzonium rosalbum* has been reported from Duke Forest (Causey, 1940); Fayetteville, Cumberland Co. (Loomis, 1971); and 3 miles SE Albemarle, Stanly Co. (Loomis, 1971). The Duke Forest and Fayetteville records appear to be examples in which both names were assigned to the same specimens. The Fayetteville and Stanly Co. specimens are actually *P. strictum* and not *P. bivirgatum* or *P. rosalbum*, as previously reported. The location of the Durham and Duke Forest specimens is unknown, and the records cannot be confirmed. In all likelihood they too refer to *P. strictum*, which is abundant in the "Triangle" (Raleigh-Durham-Chapel Hill) region. It is virtually certain that the record of *P. bivirgatum* from Durham (Loomis, 1944) is incorrect, as the species is authentically known in North Carolina from montane localities only. Except for the collection of *P. rosalbum* in High Falls, Moore Co., *P. strictum* is the only polyzoniid authentically known from the piedmont, and the other records are therefore discounted pending discovery of another individual.

**Polyzonium laterale**, new species
Figures 5–8

*Type-specimens*: Male holotype and one male and one female paratype collected by L. S. Knight, 18 October 1969, from Linville Gorge near Table Rock Mtn., in Burke Co., North Carolina (RLH).

*Diagnosis*: Distal podomere of anterior gonopods bent laterad apically, tip pointed; coxal lobe narrow, bent sharply mediad distally; sternal lobes high, broader at base than tip, narrowly separated.

*Holotype*: Length 8.2 mm, width 1.8 mm, 41 segments. Color uniformly light yellow dorsally and ventrally, becoming paler caudally. Collum large, hood-like, completely covering ocelli and first antennomeres. Head short and very broad, sides meeting in almost a right angle, apex blunt; antennae club shaped, distal segments thicker, nearly




Figs. 1–4. *Polyzonium strictum* new species (holotype, NCSM 1881). 1, Anterior gonopods, anterior view; 2, Segments 5 and 6, lateral view; 3, Leg 1 and sternum, caudal view; 4, Leg 2 and sternum, anterior view. Figs. 5–8. *Polyzonium laterale* new species (holotype, RLH). 5, Anterior gonopods, anterior view; 6, Segments 5 and 6, lateral view; 7, Sternum and basal joints of leg 1, caudal view; 8, Leg 2 and sternum, anterior view. Fig. 9. *Polyzonium bivirgatum* (Wood, 1864), specimen from Polk Co., North Carolina, 5 miles NE Saluda (NCSM 2036). Anterior gonopods, anterior view. Fig. 10. *Polyzonium rosalbum* (Cope, 1870), specimen from Madison Co., North Carolina, along U.S. hwy. 70, 0.8 miles W jct. N.C. hwy. 22 (RLH). Anterior gonopods, anterior view.

equalling sides of midbody segments when held laterally; ocelli 3–3, equidistant, first ocelli slightly larger than others, anterior interocular space subequal to diameter of ocellus, posterior interocular space 4–5 times as wide. Pores of segment 5 (Fig. 6) lower than those that follow, sides raised, interzonal stria only slightly bulging behind pores. Ultimate segment evenly rounded.

Anterior gonopods (Fig. 5) with sternal lobes high, subtriangular, wider at base than tip, bases almost contiguous; coxal lobe narrow, sharply bent mediad distally, sides gradually converging to narrow but rounded tip; distal podomere straight, bent sharply laterad apically, tip pointed. Legs 1 and 2 (Figs. 7, 8) crassate, leg 3 thinner. Sterna of legs 1 and 2 low and narrow, coxae almost touching; coxae of leg 3 more separated; sterna on other pregonopodal legs broad and low, coxae well separated; sterna on postgonopodal legs low and narrow, coxae almost touching.

*Variation*: The male paratype agrees essentially with the holotype, except that the head is more pointed, with its sides meeting in an angle of about 70°. The female paratype is much larger than either of the males (length 15 mm, width 2.3 mm, 58 segments) and has a slightly smaller collum and a pointed head (angle approximately 75°). All sterna of the female are low and narrow, with the coxae almost touching. The male from Tennessee differs considerably from those in the type series. It is brown along the caudal edge of the first 18 segments and the antennae are purplish (color pattern similar to that of *P. bivirgatum* (NCSM 2036)). The collum of the Tennessee male has a distinct reflected lip and does not completely cover the ocelli or first antennomeres; the head is broad but pointed (angle approximately 90°). On the gonopods, the coxal lobe bends less sharply distally, and the sternal lobes are more widely separated.

*Distribution*: The species is known only from the mountains of western North Carolina and extreme eastern Tennessee. Specimens have been examined as follows:

Tennessee: Carter Co., along U.S. Forest Service Rd., 4.5 miles N Shell Creek, 3500′, 1 ♂, 17 July 1965, R. L. Hoffman and K. P. Brownell (RLH).

North Carolina: Burke Co., Linville Gorge near Table Rock Mtn., 2 ♂, 1 ♀, 18 October 1969, L. S. Knight (RLH) TYPE LOCALITY.

*Remarks*: *Polyzonium laterale* was previously reported from North Carolina as *P. bivirgatum* by Loomis (1971). It is unique in the configurations of the distal podomere and coxal lobe and does not appear to be closely related to any known species.

**Polyzonium bivirgatum** (Wood, 1864)
Figure 9

*Octaglena bivirgata* Wood, 1864, *Proc. Acad. Natl. Sci. Phila., 16*: 186.
*Polyzonium bivirgatum* Cook and Loomis, 1928, *Proc. U.S. Natl. Mus.,*

*72*: 18.—Chamberlin & Hoffman, 1958, *Bull. No. 212, U.S. Natl. Mus.*, p. 188.—Loomis, 1971, *Fla. Ent.*, *54*: 155–156, figs. 6–10.

The first North Carolina record of *P. bivirgatum* was from Durham, in the piedmont (Loomis, 1944). It has since been reported from Durham; Duke Forest; and Fayetteville, Cumberland Co., by Wray (1967). The last record refers to *P. strictum*, as stated earlier, and the others probably do too. The material from Durham and Duke Forest is unavailable, however, and these records of *P. bivirgatum* are therefore discounted.

The species has also been reported from montane localities—Zionville, Watauga Co., (Wray, 1967); and Linville Gorge, Burke Co.; Madison Co. (two locations); and Mitchell Co. (Loomis, 1971). The Burke Co. record (Linville Gorge) is now assigned to *P. laterale*, as stated earlier; the Zionville material is unavailable for confirmation, although this is a plausible location for the species. Of the two Madison Co. records, one was based on a female, and I hesitate to report localities based solely on female specimens. The other, between Marshall and Hot Springs, was based on males and females unavailable to me but is also a plausible record for *P. bivirgatum*. Current evidence (from North Carolina and neighboring states) suggests that the species is restricted to montane localities in the state. The following are the two North Carolina localities which I know to be correct for *P. bivirgatum*:

Mitchell Co., Roan Mtn. below Carver's Gap, 5000′ elevation, 12♂, 4♀, 23 September 1950, L. Hubricht (RLH). Polk Co., 5 miles NE Saluda, 2♂, 16 October 1973, R. M. Shelley (NCSM 2036).

**Polyzonium rosalbum** (Cope, 1870)
Figure 10

*Petaserpes rosalbus* Cope, 1870, *Trans. Amer. Ent. Soc. 3*: 65.—Bollmann, 1888, *Proc. U.S. Natl. Mus.*, *11*: 343.

*Hexaglena cryptocephala* McNeill, 1887, *Proc. U.S. Natl. Mus.*, *10*: 328.

*Polyzonium rosalbum* Williams and Hefner, 1928, *Bull. Ohio Biol. Surv.*, *18*: 104, figs. 7–8.—Loomis, 1971, *Fla. Ent.*, *54*: 161–162, figs. 30–34.

The original North Carolina record of this species was also from Durham (Causey 1940). Loomis (1971) reported it from Fayetteville, Cumberland Co.; 3 mi SE Albemarle, Stanly Co.; and four montane localities in Madison Co. The Fayetteville and Stanly Co. records both refer to *P. strictum*, as stated earlier, and the material from Durham is unavailable. In four years of collecting in the eastern piedmont, the only polyzoniid I have encountered around Durham is *P. strictum*. It is conceivable that Causey's specimens were actually *P. rosalbum*, since I have collected this species in Moore Co. (High Falls), only 50 miles SW Durham. Without the specimens, however, the record must be

deleted until new individuals are found. Current evidence indicates that *P. rosalbum* is widely distributed in the mountains and central piedmont of North Carolina. The following are North Carolina localities which I know to be correct for *P. rosalbum*:

Madison Co., along U.S. hwy. 70, 0.8 miles W jct. N.C. hwy. 22, 3♂, 23 July 1961, R. L. Hoffman (RLH); ravine at Paint Rock, 4♂, 2♀, 13 September 1952, L. Hubricht (RLH); Hot Springs, Silver Mine Recreation Area, 1♂, 2 August 1962, R. L. Hoffman (RLH); and ravine along Southern Railroad between Hot Springs and Paint Rock, 3♂, 3♀, 2 August 1962, R. L. Hoffman (RLH). Moore Co., south bank of Deep R. at High Falls, 2♂, 28 August 1974, R. M. Shelley (NCSM 2695).

## Addendum

As the paper was going to press, I received notice from Dr. Hoffman, who had just viewed the type of *Buotus carolinus*, that the milliped was not a polyzoniid but a chordeumid of the family Tingupidae, perhaps conspecific with the immature tingupids reported by Shear (1972) from Montgomery County, Virginia.

## Literature Cited

Causey, Nell B. 1940. Ecological and systematic studies on North Carolina myriapods. Unpublished Ph.D. Thesis, Zoology Department, Duke University, Durham, North Carolina.

Chamberlin, Ralph V. 1940. On some chilopods and diplopods from North Carolina. Can. Ent. 72:56–59.

Loomis, H. F. 1944. Millipeds principally collected by Professor V. E. Shelford in the eastern and southeastern states. Psyche 51: 166–177.

———. 1971. The diplopod genus *Polyzonium* in North America. Fla. Ent. 71:179–184.

Shear, William A. 1972. Studies in the milliped order Chordeumida (Diplopoda): A revision of the family Cleidogonidae and a reclassification of the order Chordeumida in the new world. Bull. Mus. Comp. Zool. 144:151–352.

Wray, David, L. 1967. Insects of North Carolina, Third Supplement. North Carolina Department of Agriculture, Entomology Division, Raleigh, North Carolina.

. 88, No. 36, pp. 383–394 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# TWO NEW GENERA OF EUDRILID EARTHWORMS FROM NIGERIA

By A. O. Segun
*Museum of Natural History, University of Ife, Ile-Ife, Nigeria*

Few earthworms have previously been described from Nigeria and as such undescribed species are sometimes found when new collections are made. Among the eudrilid earthworms, Beddard (1891a & 1891b) described four genera and species—*Hyperiodrilus africanus, Heliodrilus lagosensis, Libyodrilus violaceus* and *Iridodrilus roseus*—from collections made in Lagos. Michaelsen (1913) recorded *Eudrilus eugeniae* from Old Calabar, Southern Nigeria and in 1915, he described *Beddardiella dalzieli* and *Eutoreutus abinsianus* from Northern Nigeria. Taylor (1949) described a new species, *Hippopera nigeriae* from Lagos and Ibadan. Clausen (1963) described two new species belonging to a new genus, *Keffia variabilis* and *K. nigeriensis* from Keffi, Jos and Kano, Northern Nigeria and *Libyodrilus mekoensis* from Meko on the Nigeria—Dahomey boundary in 1965. In a collection from Ibadan, Sims (1971) described a new genus and species, *Ephyriodrilus afroccidentalis* and recorded occurrence of *Eminoscolex steindachneri.* Segun described two new species of *Hyperiodrilus* from western and mid-western states of Nigeria (in press).

The present paper deals with the description of two new genera and species of earthworms collected from the garden soil of catering Rest houses in Vom and Jos, Benue-Plateau State, and from a farm land of the University of Nigeria, Nsukka, East Central State. Other eudrilid earthworms identified during these collections were species of *Eudrilus, Hyperiodrilus, Iridodrilus* and *Keffia.*

## Collecting Techniques

Earthworms are collected in terrestrial habitats by digging or by direct application of dilute solution of formalin (18 ml. of 40% formaldehyde in 4.5 liters of water) or about 25 ml. of concentrated formaldehyde to an area of 1.5 square meters. A dilute solution of potassium permanganate can also be used. The worms obtained when using these solutions are washed in water for a few minutes as soon as they appear on the surface.

### **Vomia**, new genus

*Description*: Eudrilinae with ab setae fairly widely, cd setae more closely paired. Male pores closely applied midventrally on segment XVII; female pores paired laterally on segment XIV; spermathecal pores paired midventrally in XIII, anterior to female pores. Oesophageal gizzard present in segment VI, intestinal gizzards and supraintestinal glands absent. Unpaired ventral oeosphageal sacs present in segments X and XI, paired dorsolateral oesophageal glands in segment XII. Holandric, 2 pairs of testes enclosed in testis sacs forming sperm reservoirs in X and XI. Paired ovo-spermathecal apparatus completely separate but connected by a short duct. Ovaries paired and enclosed in ovarian sacs in segment XIII, each ovary leading by a narrow tube into an ovisac which communicates with a fertilisation chamber at the inner (ental) end of the oviduct. Each oviduct opens out ventrolaterally in segment XIV near 13/14 furrow. Spermathecal receptacula seminis paired, left and right parts completely separate in their whole length. Small, paired, muscular spermathecal ampullae present. Paired penial setae present in segment XVII.

*Distribution*: Benue-Plateau State, Northern Nigeria.

*Type-species*: *Vomia prima* new species.

*Remarks*: The genus belongs to the *Eudrilus-Metascolex-Parascolex-Hippopera* group of West African Eudrilidae by possessing paired oesophageal glands in segment XII and ventral, unpaired, oesophageal sacs in X and XI. It resembles *Parascolex*, *Hippopera* and *Metascolex* in having separate openings for spermatheca and oviduct, but differs from *Metascolex* which possesses only one pair of testes and vesiculae seminales, and also from *Parascolex* by the single nature and the positions of the male and spermathecal pores. The spermatheca is also single in *Parascolex* for the greater part of its length. *Vomia* resembles *Eudrilus* and *Hippopera* in possessing paired male and spermathecal pores, but differs chiefly from *Eudrilus* by having separate openings for the oviducts and the spermathecae. Penial setae present in *Vomia* are completely absent in *Eudrilus*. *Hippopera* differs from *Vomia* in possessing a pair of prostatic pores (anterior male pores, Taylor, 1949) on segment XIV and clitellar pouch which covers most of the floor of the clitellum.

**Vomia prima**, new species
Figures 1–2, 4

26 clitellate specimens collected from the type-locality are now kept in the Natural History Museum, University of Ife, Ile-Ife, Nigeria. Reg. No. 1973.1.1–26.

3 clitellate specimens. British Museum (Natural History) Reg. No. 1973.27.4–6.

*External characters*: The lengths of the earthworms vary from 120 mm and the diameters in the clitellar region from 6 to 9 mm. The number of segments varies from 130 to 190. The dorsal side of the body is grey with bluish tinge, whilst the ventral side is light grey; the clitellum is light orange. The prostomium is epilobous. The clitellum is annular, occupying segments XIII to XVII. Dorsal pores are absent.

The setae have an eudriline arrangement with ab > cd; the setal formula (aa : ab : bc : cd) at segment X is 6 : 1–2 : 4 : 1, at segment XX = 16 : 2 : 6 : 1 and at segment XXX = 15 : 2 : 4 : 1. dd = ½ circumference.

The male pores are paired between aa on segment XVII, very near 17/18 intersegmental furrow where they are situated on the apices of two small protuberances. These, in turn, are found in a shallow, oval depression occupying segments XVII and XVIII (Fig. 1). Penial setae are often visible inside the pores.

The female pores are paired on small rounded papillae on XIV outside setal line d, within dd.

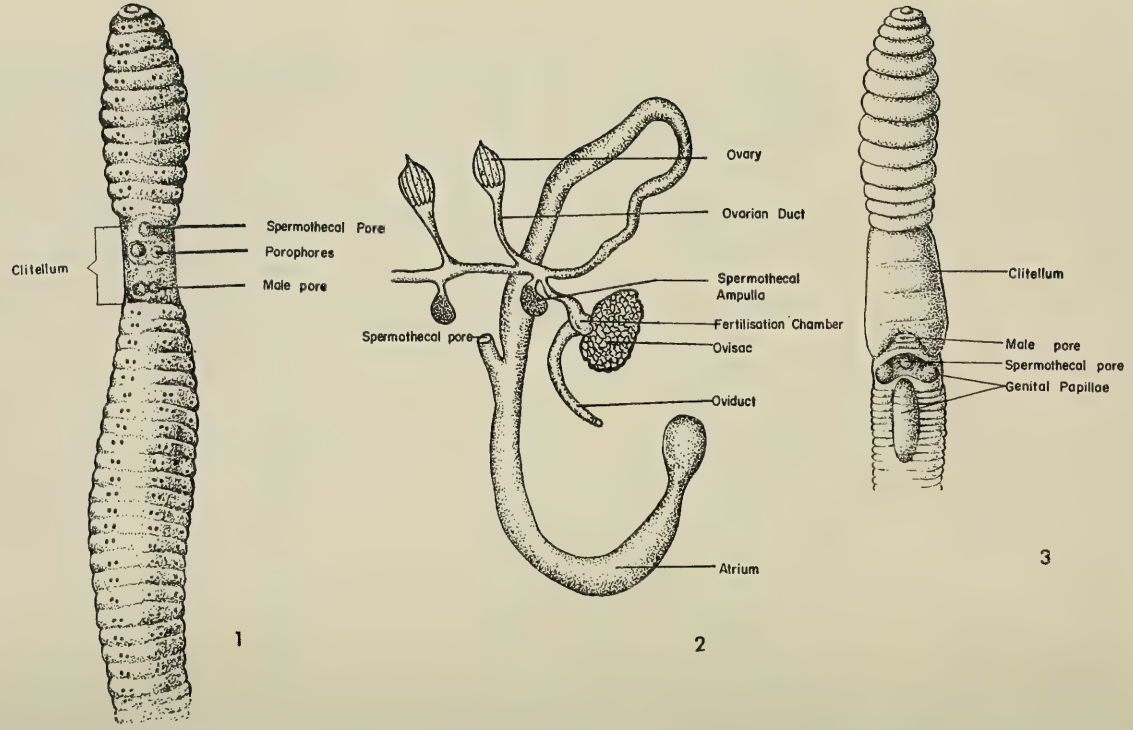
Spermathecal pores are closely paired and situated in two small depressions within setal lines aa on furrow 13/14 (Fig. 1).

A pair of porophores occupying the positions of ab on both sides are found on segment XV. No other genital papillae and markings are present.

The nephridiopores are paired in the posterior wall of each furrow within setal line cd, near c.

*Internal characters*: The first septum is 4/5. Septum 5/6 is thin; septa 6/7 to 9/10 are conical being distended by the muscular pharynx; 10/11 and 11/12 are muscular and 12/13 is less muscular.

The pharynx extends to segment IV where it leads into the oesophagus. In segment VI, the oesophagus dilates to form a large, very muscular gizzard which extends backwards to the level of segment IX. From segment VII to XV, the oesophagus is undifferentiated apart from the unpaired, midventral, pear-shaped sacs in segments X and XI, and the paired, dorsolateral glands in segment XII. These stalked oesophageal glands are closely applied to septum 12/13 and lie directly beneath the large, posterior vesiculae seminales. Each of these glands opens by a short duct into the oesophagus. The gut dilates to form the intestine in segment XV and this continues to the posterior end of the worm and terminates in an anus. The intestine is uniform throughout, intestinal gizzards, supra-intestinal glands and typhlosole being absent.




FIGS. 1–2. *Vomia prima*, n. sp.: 1, External features, ventral view; 2, Ovo-spermathecal system. Fig. 3, *Agrotoreutus nyongii*, n. sp., external features, ventral view.

The dorsal blood vessel passes anteriorly along the upper surface of the gut to segment VII where it breaks up into numerous tiny vessels to serve the gizzard. In segments X and XI, the dorsal vessel gives off branches to serve the oesophageal sacs. In the anterior region of segment XII, it gives off a pair of blood vessels, the left branch serving the oesophageal glands and the right dipping to join the subneural blood vessel. A pair of vessels are also given off in segment XIII and these run forwards to serve the same oesophageal glands. In the intestinal region, the dorsal vessel also gives off two pairs of parietal vessels in each segment. A subneural vessel runs on the left side of the ventral nerve cord from segment IX, then crosses to the right until it is joined in segment XII by the large right vessel emanating from the dorsal vessel. This subneural vessel then runs backwards directly underneath the ventral nerve cord. Branches of subneural vessel serve the female reproductive organs in segments XIII to XVI. The ventral blood vessel passes anteriorly below the gut to the pharyngeal region. It also gives off branches to serve the oesophageal gizzard. Commissural blood vessels connecting the dorsal with the supra-oesophageal blood vessel before passing down to the ventral vessel, are present anteriorly with one pair in each of segments VIII to XI.

The testes condition is holandric. Both anterior and posterior pairs are enclosed in pear-shaped sacs which lie closely against septa 10/11 and 11/12 respectively. Each of the sacs meets dorsally the opening of the corresponding vesicula seminalis with which it fuses. Ventrally, it leads into the vas deferens which pierces the septum immediately behind into the following segment. The vasa deferentia merge in segment XII and continue posteriorly to segment XVII where both of them enter into the anterior (ental) region of the euprostatic gland of its side. Vesiculae seminales are paired in segment XI and XII, the posterior pair being much larger than the anterior pair. Each of the two euprostatic glands is in the form of an elongate fingerlike process which possesses a swollen 'head' followed by a 'neck' (Fig. 4). These glands bend laterally outwards, and their ectal end is more muscular than the ental part. The sacs with the penial setae join the euprostates at the 'neck' region just behind the swollen, anterior ends. The sacs are attached to the body wall in segment XVII. The penial setae are dagger-shaped and each is divided into two mirror halves by a median line (Fig. 4).

The female generative organs are paired. Each ovary is enclosed within an ovarian capsule in XII where it lies by septum 12/13 on either side of the ventral nerve cord. An ovarian duct leads posteriorly from each capsule to an ovisac joined to the receptaculum ovorum (fertilisation chamber) (Figs. 2 & 4). The oviduct leads posterolaterally from the ectal end of each fertilisation chamber to the parietal wall in segment XIV traversing the 13/14 septum (Fig. 4).

The spermathecal system is paired. Each spermathecal pore leads to a very muscular, tubular receptaculum seminis which lies alongside

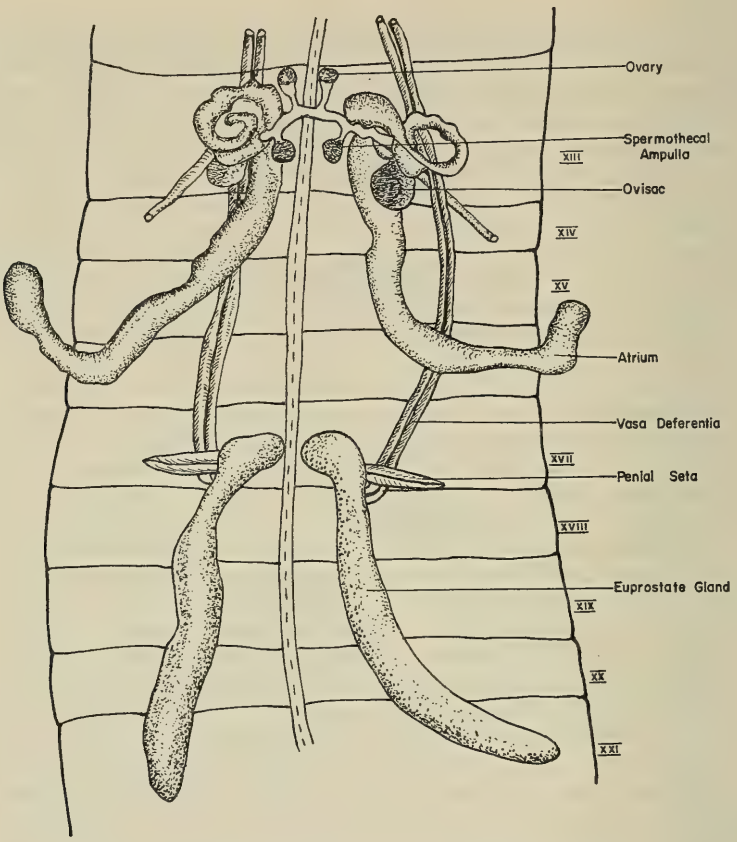



FIG. 4. *Vomia prima*, n. sp., reproductive system.

the ventral nerve cord. Sometimes, the posterior tips of the receptacula are tucked underneath the euprostate glands. Posteriorly, the receptaculum continues into segment XIV where it curves laterally and anteriorly, it narrows and curls up before joining the ovarian duct. A spermathecal ampulla is present as a small ovoid, muscular body on each side. A communication exists between the two ovo-spermathecal systems of both sides. This is in the form of a short, narrow duct connecting the two ovarian ducts (Fig. 2).

The excretory system is meganephridial with the nephridia in the clitellar regions being larger than the others. The reservoir (vesicle) of each nephridium is thick-walled and the middle portion of the nephridial duct is convoluted.

**Agrotoreutus**, new genus

*Description*: Eudrilinae with ab fairly widely, and cd more closely paired. Male pore is single on raised papilla on 17/18 furrow; female pores paired laterally on 13/14 furrow; spermathecal pore single, midventrally on papilla on 20/21 furrow, close to segment XXI, and posterior to male pore. Paired rounded genital papillae on segments XX to XXII and an almond-shaped papilla on XXIII–XXXI. Oesophageal gizzard present in segment V, intestinal gizzards absent. Paired ventral oesophageal sacs present in segments IX, X and XI, paired kidney-shaped dorsolateral oesophageal glands in segment XIII. Typhlosole present. Holandric, two pairs of testes enclosed in testis sacs forming sperm reservoirs in segments X and XI. Euprostates usually long and tubular. Ovaries paired, enclosed in ovarian sacs in segment XIII. Each ovary, found usually attached to 12/13 septum near oesophageal glands, leads by a narrow short tube into an ovisac which communicates with a fertilisation chamber at the inner (ental) end of the oviduct. Each oviduct opens to the exterior ventro-laterally in 13/14 furrow near setal line d. Spermathecal atrium single, midventral dividing ectally into two diverticula (receptacula seminis). Two pairs of penial setae present in the form of rolled tubular setae in segment XVII.

*Distribution*: East Central State, Eastern Nigeria.

*Type-species*: *Agrotoreutus nyongii*, new species.

*Remarks*: The genus belongs to the *Polytoreutus-Eupolytoreutus-Eutoreutus* group. It resembles *Polytoreutus* Michaelsen and *Eupolytoreutus* Michaelsen in having an oesophageal gizzard in segment V, one pair of oesophageal glands in segment XIII, the male pore single on 17/18 furrow and the spermathecal pore single, midventral, lying behind the male pore. But, it differs from *Polytoreutus* which possesses one pair of testes, enclosed in sacs in segment XI. Paired penial setae which are present in the newly described genus are completely absent in *Eupolytoreutus* and *Polytoreutus*.

It also resembles *Keffia* Clausen and *Eutoreutus* Michaelsen in the positioning of oesophageal gizzard in segment V and oesophageal glands in XIII, and also in the spermathecal pore being situated behind the male pore. But, the male and the spermathecal pores are paired in *Keffia* as opposed to their being single in this genus and *Eutoreutus*. The ovo-spermathecal system of the genus being described seems to be similar to the structures described for the genus *Eutoreutus*, but in the former genus, there is no "muscular copulatory pouch either situated behind and separate from the spermatheca, or opening in common with its ectal extremity" (Stephenson (1930) p. 879). Furthermore, the ventral oesophageal sacs in segments VIII to XI or segment IX to XI are unpaired in *Eutoreutus* whereas those found in the presently described genus are paired in segments IX, X and XI. This earthworm is named after Mr. E. T. Nyong, formerly of University of Nigeria, Nsukka, who first sent me a preserved specimen.

**Agrotoreutus nyongii**, new species
Figures 3, 5

12 clitellate specimens collected from the type-locality are now kept in the Museum of Natural History, University of Ife, Ile-Ife, Nigeria Reg. No. 1974.1.1–2.

2 clitellate specimens. British Museum (Natural History) Reg. No. 1974.17.8–9.

*External characters*: The lengths of the earthworms vary from 250 to 400 mm and the diameters in the widest region from 5 to 8 mm. The number of segments varies from 490 to 645, the clitellar segments are widest and the postclitellar segments are antero-posteriorly narrower than the preclitellar ones. The anterior portion of the body is pinkish whilst the posterior is bluish-purple. The body is not pigmented as the dorsal blood vessel, ventral vessel, the euprostate glands and parts of the spermathecal receptaculum show through it; the clitellum is dark yellow. The prostomium is prolobous. The clitellum is saddle-shaped, occupying segments XIV to XVII. Dorsal pores are absent.

The setal arrangement is eudriline with ab > cd; the setal formula (aa:ab:bc:cd) at segment X is 9:4:10:1, at segment XX = 9:3–6:8:1 and at segment XXX = 9:4:8:1. aa < bc on segment X whereas aa > bc on XX and XXX. dd = ½ circumference.

The male pore is single between setal lines aa on 17/18 intersegmental furrow where it is situated on a raised papilla. Two pairs of penial setae are often found protruding through the pore.

The female pores are paired and they open out laterally in 13/14 intersegmental furrow, just ventral to the nephridiopores.

The spermathecal pore is single being situated on a papilla on furrow 20/21 or segment XXI between setal lines aa (Fig. 3).

A pair of rounded genital papillae (Fig. 3) are found occupying segments XX to XXII and another almond-shaped papilla occupying segments XXIII to XXXI midventrally. No other genital markings are present.

The nephridiopores are paired in the posterior wall of each furrow from segment III within setal lines cd.

*Internal characters*: The first septum, 4/5, is thin. Septum 5/6 is intermediate in thickness between the preceding septum and septa 6/7 to 10/11 which are thickened and conical. Septum 11/12 is thinner but conical.

The buccal cavity opens into a large, muscular pharynx which extends to segment IV where it leads into the oesophagus. A number of dilator muscles attach the wall of the pharynx to the body wall. The oesophagus dilates in segment V to form the large, muscular and almond-shaped gizzard. The oesophagus then passes posteriorly and it is undifferentiated apart from the three paired glands which are present as ventral reddish pouches, a pair in each of segments IX, X and XI, and the paired bean-shaped oesophageal glands dorsolaterally in segment XIII. The

intestine begins in segment XVII and runs uniformly throughout to the terminal anus. There are neither intestinal gizzards nor supraintestinal glands, but a median typhlosole is present.

The dorsal blood vessel passes anteriorly along the intestine and the oesophagus to the pharynx. It is very large in segment XIII where it gives off two pairs of vessels. While the posterior pair serve the dorsolateral oesophageal glands, the left anterior vessel serves the spermathecal ducts of its side, crosses over underneath the oesophagus and joins the right anterior vessel to run alongside the ventral nerve cord. This blood vessel later becomes the subneural vessel in segment XIX. In segments VI to XI, paired commissural blood vessels encircle the oesophagus and interconnect the supraoesophageal with the dorsal vessel segmentally before passing down to the ventral blood vessel. They become progressively larger from VI to XI and function as lateral hearts since they are all contractile. A supraoesophageal blood vessel exists in VI to XI, and in each of IX, X and XI, it gives off paired vessels to the ventral oesophageal glands. A suboesophageal vessel gives rise to two rather large blood vessels in VI. These vessels run underneath the oesophageal gizzard to serve the pharyngeal region. The ventral blood vessel gives off four pairs of vessels to the ovospermathecal complex in segment XIII and then runs over the receptaculum seminis alongside the nerve cord. It gives off several branches in segments XVI to XXI and then dips downwards to lie above the nerve cord for the remaining length of the animal.

The testes are holandric being paired in segments X and XI. Each is enclosed in a testis sac. A short duct leads posteriorly from the dorsal end of each testis sac through the septum into the seminal vesicle in the following segment. The testis sacs also contain the ciliated sperm funnels. The seminal vesicles are paired in segments XI and XII, the posterior pair being much larger. A vas deferens runs from the end of each testis sac and passes through the corresponding septum (10/11 and 11/12 respectively). The two vasa deferentia of each side unite in segment XIII and run posteriorly side by side over the parietal wall. From segment XIX, these ducts run along the edge of the euprostatic glands until they pass into these glands in segment XXII. The euprostates are paired, muscular, elongated and sausage-shaped occupying segments XV or XVI to XXXII. They are narrow anteriorly (entally) and the tapering anterior ends of both glands meet below both the nerve cord and spermathecal atrium (Fig. 5) before opening out at the single ventral male pore in furrow 17/18. The pairs of penial setae which are curved at the tips and which are in form of rolled tubes join the euprostates prior to their opening out.

The ovaries are paired in segment XIII and each with the ovisac is enclosed in a pink, transparent and thin-walled ovarian vesicle. An ovarian duct leads posteriorly from each ovary to join an efferent duct which leads into the receptaculum ovorum (fertilisation chamber). From

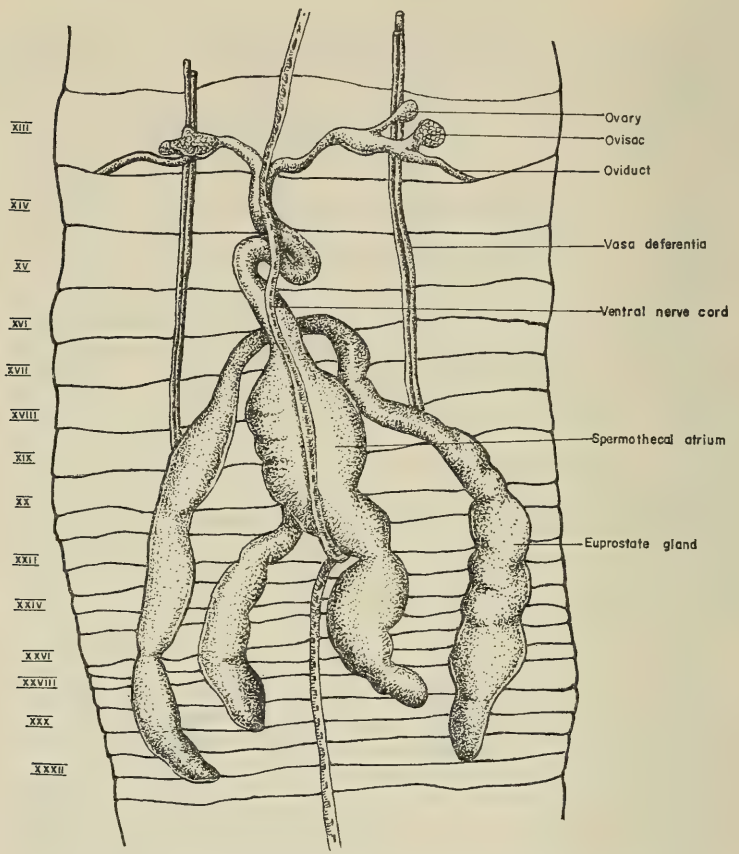



FIG. 5. *Agrotoreutus nyongii*, n. sp., reproductive system.

here, the oviduct leads posterolaterally to open out in 13/14 furrow (Fig. 5).

The spermathecal pore is single, midventral on 20/21 furrow and it leads into a muscular sac-like atrium which is situated below the ventral blood vessel and nerve cord. This immediately splits into two fingerlike, thin-walled appendages, the receptacula seminis, which occupy segments XXI to XXVIII, XXIX or XXX and in some cases to segment XXXIV on either side of the nerve cord. Anteriorly, the atrium maintains its baggy shape until it narrows in segment XVII to form a spermathecal tube. In segment XV, this tube bends upon itself to become U-shaped on the left side (sometimes to the right). It then bifurcates, immediately after penetrating 13/14 intersegmental septum, into right

and left narrow efferent ducts thereby becoming Y-shaped. This therefore means that the spermathecal system is paired both anteriorly and posteriorly, but remains single medially (Fig. 5).

The excretory system is meganephridial with one pair of nephridia to each of the segments from segment V backwards. Nephridia in the clitellar region are of the same size as the others.

Acknowledgments

My thanks are due to Mr. R. W. Sims of Department of Zoology, British Museum (Natural History) for criticising the description of the newly described earthworms, and to Professor L. B. Halstead for his useful suggestions.

Literature Cited

Beddard, F. E. 1891a. On the structure of two new genera of earthworms belonging to the Eudrilidae, and some remarks on *Nemertodrilus*. Quart. Jour. Microscop. Sci. 32:235–278.

———. 1891b. Preliminary account of an earthworm from West Africa referable to a new genus. Proc. Zool. Soc. London 1891:172–176.

Clausen, M. W. 1963. Two new genera and three new species of earthworms from West Africa. Vidensk. Medd. Dansk Naturhist. Foren. 126:1–15.

———. 1965. Description of two new species of *Libyodrilus* Beddard 1891, the remarks on the genus and on the female system in one family Eudrilidae. Vidensk. Medd. Dansk Naturhist. Foren. 128:273–292.

———. 1967. The African oligochaete genera *Hyperiodrilus* Beddard, 1891 and Legonea Clausen, 1963 (Oligochaeta). Vidensk. Medd. Dansk Naturhist. Foren. 130:179–207.

Michaelsen, W. 1913. Oligochaten vom tropischen und südlich-subtropischen Africa II. Zoologica, Stuttgart, Heft 68:1–63, pls. 1–2.

———. 1915. Oligochaten: Ergeb. 2. Zweit. Deutschen Zentral-Afrika-Exp. 1910–11. Bd. 1, Zool. Teil 1:185–307. Leipzig.

Sims, R. W. 1965. Acanthodrilidae and Eudrilidae (Oligochaeta) from Ghana. Bull. Brit. Mus. (Nat. Hist.) Zool. 12:283–311.

———. 1967. Earthworms (Acanthodrilidae and Eudrilidae: Oligochaeta) from Gambia. Bull. Brit. Mus. (Nat. Hist.) Zool. 16: 1–34.

———. 1971. Eudrilinae from Southern Nigeria and a taximetric appraisal of the family Eudrilidae (Oligochaeta). Jour. Zool. London 164:529–549.

Stephenson, J. 1930. The Oligochaeta. Oxford, Clarendon Press, xiv + 978 pp.

Taylor, A. G. 1949. A West African earthworm (*Hippopera nigeriae*), belonging to a new family, Hippoperidae. Proc. Zool. Soc. London 119:703–710.

3

QH
1
B4X
NH

No. 37, pp. 395–398 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# A NEW *WATOPHILUS* FROM UTAH, INCLUDING A LIST OF ALL KNOWN SPECIES (CHILOPODA: GEOPHILOMORPHA: CHILENOPHILIDAE)

By R. E. Crabill, Jr.
*National Museum of Natural History,*
*Smithsonian Institution, Washington, D.C.*

In his 1929 monograph of the Order, Attems was unable to present a key for Chamberlin's species of *Watophilus*. I am unable to do so now, and for the same reasons: they are inadequately described, and I have never seen a specimen other than the one presented here as new. An adequate discussion of the critical diagnostic characters is nowhere in the literature. Neither have I been able to locate the typical specimens in the several Chamberlin Collections. In 1964 when I conferred last with Professor Chamberlin, he revealed that many, perhaps most, of his types described prior to 1913 could not be located; he presumed them to be lost. Most of the Chamberlin forms presented here were described before 1913. I am therefore, at the moment, unable to do more than present a list of the known species; all are North American. Hopefully, additional *Watophilus* material will be collected in the future.

The genus, whose members are apparently very rarely collected, is clearly most closely related to the ubiquitous Holarctic genus *Arctogeophilus*, whose many species are commonly encountered in temperate to arctic North America. Both belong to a very small suite of chilenophilid genera one of whose notable features, in my opinion, is the absence of a ventral condyle on the second maxillary telopodite. So far as I am aware, this remarkable condition escaped the notice of Verhoeff and Attems. The presence in *Watophilus* of spinous processes on the second maxillary telopodite distinguishes it both from *Arctogeophilus* and all other North American chilenophilids.

Although I am at the moment unable to distinguish all of the species of *Watophilus* from one another, it is possible to say, even from what little is known of them, that the species presented here as new cannot be referable to any other known member of the genus. All previously described species are said to possess a distinct tuberculate ultimate pedal pretarsus; *knowltoni*, new species, lacks an ultimate pedal pretarsus altogether.

Possibly the new form is most like *utus* Chamberlin, known only from Utah, in which case they differ as follows. In *utus*: (1) pedal pairs, 65. (2) Ultimate pretarsus present and tuberculate. (3) Prehensorial segments 2 and 3 each with a small denticle. In *knowltoni*: (1) pedal pairs, 49. (2) Ultimate pedal pretarsus absent. (3) Prehensorial segments 2 and 3 unarmed.

**Watophilus knowltoni**, new species[1]

*Holotype*: female. Utah: Box Elder Co., Kelton Pass, in juniper duff; April 28, 1969; George F. Knowlton, leg. Deposited in the National Museum of Natural History.

*Description*: General. Body length, 13 mm. Color, light yellow throughout. Body posteriorly gradually attenuate. Pedal segments, 49. Antennae. Relatively long, ca. 2.8× longer than the head. Articles: filiform, each longer than wide; the more proximal articles with relatively few long setae, distally these increasing in number and becoming shorter. Ultimate article mesally and ectally at midlength and distal thereto with a patch of short robust hyaline modified setae. Cephalic Plate. Substantially longer than wide (37:26). Shape: sides evenly slightly excurved; rear margin evenly rounded, excurved. Frontal suture absent. With two paramedian bands of coarse areolation extending from rear margin to labral level. Prebasal plate not evident. Clypeus. Anterocentrally with a small poorly-defined clypeal area (fenestra *apud* Chamberlin) within which are 2 long setae; immediately anterior thereto on each side is a long seta. With a pair of prelabral setae; clypeus otherwise glabrous. Paraclypeal sutures slightly sinuous, complete. Labrum. Sidepieces meeting centrally. Midpiece with long hyaline filaments. Clypeolabral suture distinct and complete. First Maxillae. Coxosternum: anteroposteriorly very deep, undivided, not suturate; lappets scrabrous, short, attaining only end of telopodite 1st article; medial lobes basally broad, narrowing rapidly distally. Telopodite: bipartite; lappet thick, robust, scabrous; extending slightly beyond end of telop-

[1] Named in honor of Dr. George F. Knowlton, valued friend of many years, generous and tireless collector, whose efforts for decades have contributed to our knowledge of Utah, his native state.

odite. Second Maxillae. Isthmus: undivided and uniformly areolate, not hyaline; extending posteriorly beyond level of pore. Coxosternite: statumen well-developed, its posterior end curving anteroposteriorly; anteromesal projection absent; ventral condyle absent, dorsal condyle present. Telopodite: 1st article basally much narrower than the expanded distal half, anteromesal and anteroectal corners each with a small spinous process; 2nd article anteroectally with a similar though much smaller process (it is virtually abortive); ultimate article (homologue of a claw) is a short, blunt, minutely spinous tubercle. Forcipular Segment. Flexed prehensors exceeding anterior margin of head. Prehensor: 1st article very long, anteromesally with a blunt, unpigmented denticle; articles 2 and 3 unarmed. Tarsungula: with a large, pigmented, pointed basal denticle; ungular blade edges smooth, not serrulate, the blade relatively short and robust. Poison calyx very small, suborbicular, its digitiform appendices extending only posteriorly; poison gland elongate, housed in articles 1, 2, and 3. Prosternum. Pleurograms absent. Pleuroprosternal sutures straight, parallel to prosternal margin, complete for ca. 95% of their length, anteriorly not quite attaining margin. Anteromedial denticles absent. Tergites. Basal plate neither sututate nor sulcate, trapezoidal. Remaining tergites (except ultimate pedal) longitudinally bisulcate. Legs. Sparsely clothed with very long setae. Pretarsi: anterior parungues uncommonly long, ca ⅔ as long as their claws; posterior parungues present but minute, virtually abortive. Sternites. Without glandular pores. Midlongitudinally weakly sulcate. Setae few, short. Ultimate Pedal Segment. Pretergite not bilaterally fissate. Tergite: sides notably excurved; greatest length exceeding greatest width; rear margin narrowly rounded. Sternite: shape trapezoidal; posteriorly truncate; sides straight, convergent; greatest length exceeding greatest width. Coxopleuron: only slightly inflated and virtually glabrous; pores anteroventrally and mostly exposed, there numbering 4–5, and anterodorsally and concealed beneath the pretergite, there numbering 2–3. Ultimate leg: ¼ longer than the penult; articles slightly inflated, each much longer than wide; ventrally on trochanter through tibia with numerous tiny setae, in addition all articles sparsely clothed with very long setae. Tarsus: bipartite; first article slightly longer than second; article 2 subclavate, distally blunt, without a pretarsus of any sort; apically with a minute seta. Postpedal Segments. Female gonopods flat, entirely fused medially without demarcation, unipartite. Anal pores prominent, lateral.

### The Known Species of *Watophilus*[2]

Subgenus *Watophilus* Chamberlin, 1912A: 662

1. *alabamae* Chamberlin, 1912B: 421.
   —Type-locality: Anniston, Mapleville, Tallulah Falls, Ga.
   —Elsewhere recorded only from South Carolina.

[2] It was plainly Chamberlin's intent to present *Watophilus* as new in the M.C.Z. Bulletin issued in April of 1912. Therein he stated that its type-species is *alabamae*,

2. *errans* Chamberlin, 1912A: 662.
   —Type-locality: Berkeley, Cal.
   —No other record.
3. *knowltoni* Crabill, here described.
   —Type-locality: Kelton Pass, Box Elder Co., Utah.
   —No other record.
4. *laetus* Chamberlin, 1912A: 662.
   —Type-locality: Berkeley, Cal.
   —Elsewhere recorded from Stanford, Pacific Grove, Cal.
5. *utus* Chamberlin, 1928: 95.
   —Type-locality: La Sal Mountains, San Juan Co., Utah.
   —No other record.
6. *dolichocephalus* (Gunthorp, 1913: 169).
   —Type-locality: Cowley Co., Kans.
   —No other record.

## Literature Cited

Attems, Carl Graf. 1929. Geophilomorpha. Das Tierreich. Lief. 52:1–388.

Crabill, Ralph E., Jr. 1955. On the identity of the Gunthorp types. Can. Entomol. 87(5):221–223.

Chamberlin, Ralph V. 1912a. The Chilopoda of California III. Pomona Journ. Entomol. 4(1):651–672 (February).

———. 1912b. The Geophiloidea of the Southeasten States. Bull. Mus. Comp. Zool. Harvard 54(13):407–436 (April).

———. 1928. On three chilopods from the La Sal Mountains of Utah. Entomol. News 39:93–96.

Gunthorp, Horace. 1913. Annotated list of the Diplopoda and Chilopoda with a key to the Myriapoda of Kansas. Univ. Kansas Sci. Bull. 7(6):161–182.

---

the only species mentioned in that publication. However, the generic name first appeared in print in the February 1912 issue of the Pomona Journal of Entomology, at which time the genus, there *not* presented as new, was said to contain only two species, *laetus* and *errans*: no type-species was mentioned. Therfore Chamberlin's fixation of the type-species, *alabamae*, is neither through original designation nor monotypy, rather through subsequent designation.

QH
1
B4X
NH

o. 38, pp. 399–428 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES
FEB 3 1976

# A REPORT ON THE FIFTH INTERNATIONAL SYMPOSIUM ON PLECOPTERA

By Richard W. Baumann
*Smithsonian Institution, Washington, D.C. 20560*

The first international Plecoptera symposium to be held in the new world took place September 3–6, 1974, in Washington, D.C. The four previous meetings were all in Europe (Switzerland, 1956, Austria, 1960, Germany, 1963, and Sweden, 1968) therefore, this meeting provided an excellent opportunity for American and European scientists to become better acquainted and exchange information on current research.

The symposium was sponsored by the Smithsonian Institution with the aid of the Office of Academic Affairs and the Department of Entomology. The international committee consisted of: R. W. Baumann, Smithsonian Institution, Washington, D.C., USA, Organizing Chairman; J. Illies, Max-Planck Limnology Institute, Schlitz, West Germany, Honorary Chairman; C. G. Froehlich, University of São Paulo, São Paulo, Brazil; P. P. Harper, University of Montreal, Montreal, Quebec, Canada; T. Kawai, Nara Women's University, Nara, Japan; A. Lillehammer, University of Oslo, Oslo, Norway; I. D. McLellan, Westport, New Zealand; K. W. Stewart, North Texas State University, Denton, Texas, USA; P. Zwick, Max-Planck Limnology Institute, Schlitz, West Germany.

Meetings were held during the days of September 3–5 in the Carmichael Auditorium of the Smithsonian Institution, National Museum of History and Technology. The opening session on the morning of September 3 included a welcome by the chairman and greetings by local dignitaries and was

FIG. 1. Group picture in front of Museum of History and Technology.

highlighted by an invitational lecture by Professor Dr. Joachim Illies entitled, "The Status of Plecoptera Research Today." Professor Illies recounted the history of plecopterology and ended by noting that although much has been accomplished, there is still a lot to learn about all aspects of Plecoptera.

FIG. 2. Symposium participants, left to right: Peter Zwick, Joachim Illies and Dragica Kaćanski.

FIG. 3. Portion of symposium audience during presentation of a paper.

FIG. 4. Field trip, left to right: Ian D. McLellan, Paul J. Spangler, Henry W. Woolman, III.

The submitted papers were organized into five groups according to content and were presented as listed below:

Tuesday, September 3, 1974 (Afternoon)

Section leader: K. W. Stewart, Texas, USA.

Basic Principles and Practices in Zoological Nomenclature,
by C. W. Sabrosky, Washington, D.C., USA.

The Phylogenetic System of the Order Plecoptera,
by P. Zwick, Schlitz, Germany.

Notes on Nomenclature and Taxonomic Growth of the Plecoptera,
by G. C. Steyskal, Washington, D.C., USA.

Numerical Taxonomic Analysis of Relationships in Plecoptera.
by C. H. Nelson, Tennessee, USA.

Scientific Illustration-Techniques and Media.
by G. L. Venable and M. Druckenbrod, Washington, D.C., USA.

Fig. 5. Field trip, left to right: Rebecca F. Surdick, Oliver S. Flint, Jr., Briant R. Oblad.

Wednesday, September 4, 1974 (Morning)

Section leader: P. P. Harper, Montreal, Canada.

Notes on the Nearctic Genera of Perlidae.
by B. P. Stark, Utah, USA.

The *Isoperla* of Texas.
by S. W. Szczytko, Texas, USA.

Notonemouridae-Systematics and Distribution.
by J. Illies, Schlitz, Germany.

The Family Nemouridae.
by R. W. Baumann, Washington, D.C., USA.

African Species of the Genus *Neoperla* Needham (Perlidae).
by P. Zwick, Schlitz, Germany.

(Afternoon)

Section leader: C. H. Nelson, Tennessee, USA.

Mating Behavior of *Paragnetina fumosa*, *Perlinella drymo* and *Hydroperla crosbyi*; with Special Emphasis on External Sperm Transfer in *H. crosbyi* (film).
by K. W. Stewart, Texas, USA.

An Emergence Sequence of Chloroperlidae in a Northeastern Ohio Stream.
by M. A. Tkac, Jr., Ohio, USA.

Emergence Patterns in Plecoptera.
by P. P. Harper, Montreal, Canada.

The Structure (Ultra) and Function of the Ventral Lobe and the Hammer of Plecoptera.
by R. Rupprecht, Mainz, Germany.

Thursday, September 5, 1974 (Morning)

Section leader: P. Zwick, Schlitz, Germany.

The Stoneflies (Plecoptera) of the Rocky Mountains.
by A. R. Gaufin, Utah, USA.

Preliminary Studies on Pennsylvania Stoneflies.
by R. F. Surdick, Pennsylvania, USA.

Biogeography of New Zealand Plecoptera.
by I. D. McLellan, Westport, New Zealand.

A Preliminary Report of the Plecoptera Fauna in Bosnia and Herzegovina (Yugoslavia).
by D. Kaćanski, Sarajevo, Yugloslavia.*

(Afternoon)

Section leader: I. D. McLellan, Westport, New Zealand.

Autohemorrhage in Two Stoneflies and its Effectiveness as a Defense Mechanism.
by E. F. Benfield, Virginia, USA.

Some Morphological Features of Gills in Plecoptera.
by N. N. Kapoor, Montreal, Canada.

Notes on the Family Scopuridae.
by T. Kawai, Nara, Japan.

Distribution of Stoneflies (Plecoptera) Within the Hubbard Brook Watershed, New Hampshire.
by S. M. Fiance, New York, USA.

During the extra time made available, because some participants could not attend, some very interesting extemporaneous presentations were given. William E. Ricker explained the derivations of many of the names that he has proposed for Plecoptera genera and species. Joachim Illies showed films of the two most recent Plecoptera meetings

* Paper not given at this time but abstract included.

in Germany and Sweden and presented the results of his emergence control studies on Breitenbach.

Those in attendance on September 3 were recorded in the group picture. Everyone that attended the symposium and registered is listed at the end of this report along with their current address.

The first issue of the plecopterists newsletter *Perla* was distributed and all felt that it was a positive step forward. Plans were made to continue the newsletter at approximately one-year intervals.

A Plecopterists Luncheon was held in the Commons Room of the original Smithsonian Building on September 4 where all present were able to mingle and make new friends. The ladies in attendance at the Symposium were able to participate in an excellent program organized by Carol M. Flint.

The final day, September 6, was the field trip led by Dr. Oliver S. Flint, Jr., to the Bull Run Mountains in Northern Virginia. Although it rained most of the day and the interest of some was dampened, most everyone experienced a day to remember.

One of the major objectives of this symposium was to bring together young plecopterists to meet and learn directly from the established experts in the field. This was realized because approximately one-third of the participants were students and the open forum type of discussion allowed for free interchange of ideas. After hours contact was made difficult because of the housing arrangements available but hopefully this will be corrected in the next symposium tentatively scheduled to be held in Schlitz, West Germany.

## Abstracts of Presented Papers

### BASIC PRINCIPLES AND PRACTICES IN ZOOLOGICAL NOMENCLATURE.

by Curtis W. Sabrosky, *Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington, D.C.*

The history of successive international codes of zoological nomenclature was briefly reviewed, from the first in 1905 (then called the Règles, or Rules) to the 1961 and 1964 editions of the Code, to changes made at Monaco in 1972 and at Ustaoset in Norway in 1973. An Editorial Committee is now working on a 3rd edition that will, hopefully, be ready for final approval in late 1976.

Basic principles were listed and discussed briefly:

1. The Priniciple of Availability
2. The Principle ("Law") of Priority (with Conservation a Limitation on Priority)
3. The Language of Scientific Names
4. The Principle of Coordination
5. The Principle ("Law") of Homonymy
6. The Principle of Typification

Terminology: Definitions or explanations were offered for certain nomenclatural jargon: nominal genus, junior and senior, objective and subjective, primary and secondary.

A few "do's" and "don't's" that would help in avoiding nomenclatural difficulties and expedite taxonomic work were suggested.

## THE PHYLOGENETIC SYSTEM OF THE ORDER PLECOPTERA.

BY PETER ZWICK, *Limnologische Flußstation des Max-Planck-Instituts für Limnologie, Germany.*

Animals can be classified in many ways, to serve many purposes and these systems may be altered or abandoned, according to the needs of their users. However, taxonomy is then reduced to a subordinate mean, a file for other disciplines and such taxonomy cannot assist in scientific research.

A more adequate way to treat taxonomy or systematics is as a science of its own, equal in rank to other sciences, with rules and procedures following scientific logic, and nothing else. Under no circumstances may these rules be bent or modified to suit other demands. The aim of such scientific taxonomy is establishment of the one system which evolved in time. Scientific taxonomy attempts to elucidate the genealogical relationships between species and supraspecific taxa of a given time, in the present or in the past. These relationships are represented in unmistakable ways, either in written systems or in cladograms. Each of these two representations can be transformed into the other, without ambiguity or loss of information. Strict monophyly of supraspecific taxa is mandatory, paraphyletic or polyphyletic taxa are not admitted. Such a system has been termed phylogenetic by Hennig (1949).

A brief account of the principles of phylogenetic systematics has been given in English by Hennig (1965). Brundin has also extensively dealt with it several times, e.g. 1966. For those who are critical of the theory of phylogenetic systematics it would be important to know its recent formulation by Schlee (1971), which is without some of the corollaries that have at times been taken to be essentials of the theory.

Unfortunately, the former "evolutionary taxonomists" have started to use the term phylogenetic systematics for their classifications. They even try to refuse the use of the term according to its older definition by Hennig. This is unfortunate, because phylogenetic systems of evolutionary taxonomists lack a clear concept. They are mixtures of "science, most strictly speaking, and of an art" (Simpson, 1961). Therefore, these systems are equivocal and are in fact little more than the usual intuitive taxonomy with evolutionary flavouring, unsuited for scientific work.

The phylogenetic system of Plecoptera (in the sense of Hennig) shown below (Fig. 6), was briefly discussed (for details see Zwick, 1973).

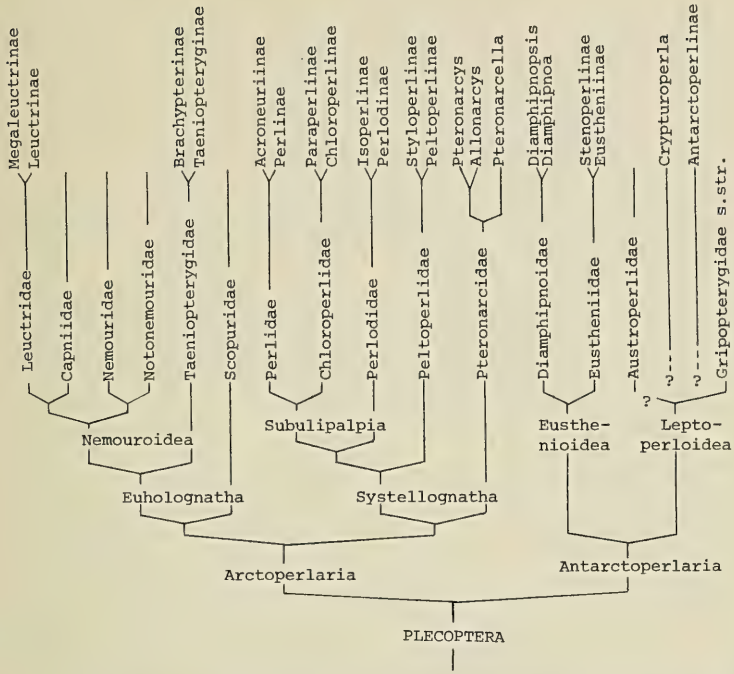



Fig. 6. The phylogenetic system of Plecoptera (from Zwick, 1969, modified).

## Literature Cited

Brundin, L. 1966. Transantarctic relationships and their significance, as evidenced by chironomid midges . . . . .—Kungl. Svenska Vetenskapsakad. Handl., 4 Ser. 11(1):1–472, 30 pls. (Stockholm).

Hennig, W. 1949. Zur Klärung einiger Begriffe der Phylogenetischen Systematik. Forsch. Fortschr., 25:137–139 (Berlin).

———. 1965. Phylogenetic Systematics. Ann. Rev. Ent. 10:97–116 (Palo Alto).

Schlee, D. 1971. Die Rekonstruktion der Phylogenese mit Hennigs Prinzip. Aufs. Reden Senckenberg. Naturf. Ges. 20:1–62 (Frankfurt).

Simpson, G. G. 1961. Principles of animal taxonomy. 247 pp. (New York).

Zwick, P. 1969. Das Phylogenetische System der Plecopteren als Ergebnis Vergleichend-Anatomischer Untersuchungen. Thesis, Univ. Kiel, 291pp; Abstract, 4 pp.

———. 1973. Insecta: Plecoptera. Phylogenetisches System und Katalog. Das Tierreich, 94:I–XXXII, 1–465 (Berlin, New York).

## NOTES ON THE NOMENCLATURE AND TAXONOMIC GROWTH OF THE PLECOPTERA.

BY GEORGE C. STEYSKAL, *Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA, c/o National Museum of Natural History, Washington, D.C.*

Students of the Plecoptera are fortunate in having up-to-date catalogues and a systematic compendium of the order in the works of Illies (1966) and Zwick (1973). The literature of few orders of insects is so well indexed and the classification so well revised by the most modern methods.

| Order and Suborder | Group | Superfamily | Family |
|---|---|---|---|
| Plecoptera | | | |
| Antarctoperlaria | | Eustheniodea | Eustheniidae |
| | | | Diamphipnoidae |
| | | Gripopterygoidea (Leptoperloidea) | Austroperlidae |
| | | | Gripopterygidae |
| | | | Gripopteryginae |
| | | | Leptoperlinae |
| | | | Paragripopteryginae |
| | | | Antarctoperlinae |
| Arctoperlaria | Systellognatha | (Pteronarcyoidea) | Pteronarcyidae |
| | | (Peltoperloidea) | Peltoperlidae |
| | | Perloidea (Subulipalpia) | Perlodidae |
| | | | Perlidae |
| | | | Chloroperlidae |
| | Euholognatha | Scopuroidea | Scopuridae |
| | | Nemouroidea | Taeniopterygidae |
| | | | Notonemouridae |
| | | | Nemouridae |
| | | | Capniidae |
| | | | Leuctridae |

The "Argumentationschema" on p. 2 and the dendrogram on p. 16 of the work by Zwick are to some extent at variance with the classification followed in the catalogue and the systematic index, which is as shown above. The genus *Crypturoperla* is shown in the Schema as of equal rank with the Austroperlidae, but in the catalogue and the systematic index the genus is treated as a member of that family. The Antarctoperlinae are treated in the Schema as of equal rank with the

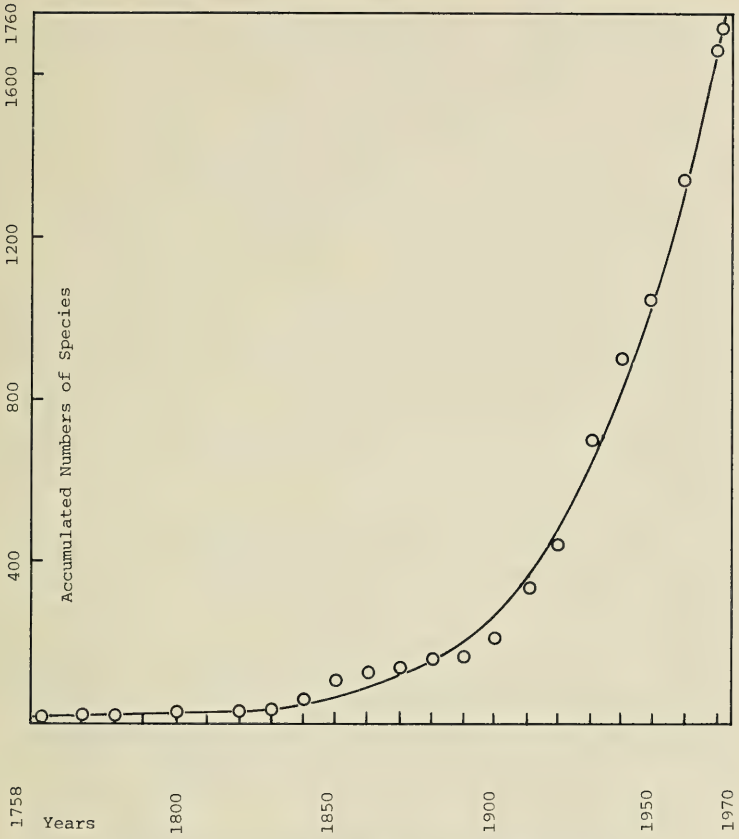



FIG. 7. Taxonomic growth curve of Plecoptera.

families Austroperlidae and Gripopterygidae, while in the catalogue the subfamily is placed under the Gripopterygidae.

The nomenclature of superfamilies in the foregoing chart has been made consistent by the replacement of the names Leptoperloidea and Subulipalpia by names based on those of the oldest included families, Gripopterygidae and Perlidae, respectively.

Inasmuch as the genitive of the Greek word ἄρκυς is ἄρκυος, which in classical Latin transcription is *arcyis*, the stem of *Pteronarcys* is *pteronarcy-* and the family-group names based thereupon should be Pteronarcyidae and Pteronarcyoidea.

A few corrections of gender of species-group names should be noted: *Desmoneura pulchellum* should be *D. pulchella.*

*Dictyogenus* and *Isogenus* should be neuter, inasmuch as the word genus is of that gender in both Latin and Greek (γενος). Two species-names should therefore be *Dictyogenus alpinum* and *D. ventrale.*

*Etrocorema* is neuter; the species-name should be *nigrogeniculatum.*

*Perlinodes* and *Perlodes* should be masculine according to Art. 30.a.ii (examples) of the Code; the names of 4 species should be *Perlinodes aureus, Perlodes frisonanus, P. intricatus,* and *P. jurassicus.*

*Pseudomegarcys japonicus* should be *P. japonica.*

*Taenionema* should be neuter: *T. californicum, T. frigidum, T. nigripenne, T. oregonense, T. pacificum, T. pallidum, T. raynorium, T. vanduzeeum.*

The generic name *Apteryoperla* is a strange formation. It probably should have been *Apterygoperla,* but there is no justification under the Code for emending it. A similar condition prevails in regard to the species-name of *Trinotoperla woodwardy*; emendation to *woodwardi* cannot strictly be justified.

A compilation of the dates of original description of the presently recognized species of Plecoptera may be charted as shown in Figure 7. For similar charts of other groups and discussion, see Steyskal (1965, 1967, 1973) and Vecht (1973). The sharply rising curve, with no indication of reversal, indicates that the order is about half known. About as many species as have already been named still await discovery and naming.

### Literature Cited

Illies, J. 1966. Katalog der Rezenten Plecoptera. Das Tierreich, Lfg. 83.

Steyskal, G. C. 1965. Trend curves of the rate of species description in zoology. Science, N.Y. 149(3686):880–882.

———. 1967. Another view of the future of taxonomy. Syst. Zool. 16:265–268.

———. 1973. Notes on the growth of taxonomic knowledge of the Psocoptera and on the grammer of the nomenclature of the order. Proc. Ent. Soc. Wash., 75:160–164.

Vecht, J. van der. 1973. Insekten Zonder Tal: een Uitdaging. Versl. Zitt. Wisnatuurk. Afd. K. Akad. Wet. Amst. 82(3):41–48.

Zwick, P. 1973. Insecta: Plecoptera, Phylogenetisches System und Katalog. Das Tierreich, Lfg. 94.

## NUMERICAL TAXONOMIC ANALYSIS OF RELATIONSHIPS IN PLECOPTERA.

by Charles H. Nelson, *Department of Biology, University of Tennessee, Chattanooga, Tennessee.*

The application of numerical taxonomic procedures for analyzing phyletic relationships within the Plecoptera is undertaken. In order

to demonstrate the usefulness of these methods, 25 two-state and 13 multi-state characters were obtained from the species comprising the family Pteronarcidae. Quantitative phenetic procedures used to analyze these characteristics included the single-linkage cluster analysis, unweighted pair-group method using arithmetic averages (UMPGA), weighted pair-group method using arithmetic averages (WMPGA) and the function-point cluster method (FPCM). Quantitative cladistic procedures included the weighted invarient step strategy (WISS) and various methods for forming Wagner networks and trees. In addition, a Wagner network and several Wagner trees were constructed for the major taxonomic groups of the Plecoptera using data obtained from Zwick's (1973) study. The phenetic clustering techniques when applied to the pteronarcid data resulted in the identification of three principle clusters which agreed with the accepted classification of this family. In general, cladistic analyses agreed closely with those results obtained from using the classical method of Hennig, indicating that numerical cladistic procedures are consistent with the principles of "phylogenetic systematics".

## SCIENTIFIC ILLUSTRATION-TECHNIQUES AND MEDIA.

BY GEORGE L. VENABLE AND L. MICHAEL DRUCKENBROD, *National Museum of Natural History, Smithsonian Institution, Washington, D.C.*

An introduction was given into the goals and functions of scientific illustration, and its' advantages over photography. The types of illustrations were discussed as were the equipment and media used in each. Step by step instruction was given for both line and tone illustrations, and various methods mentioned to enable the scientist to produce his/her own illusrations, both economically, and accurately.

## NOTES ON THE NEARCTIC GENERA OF PERLIDAE.

BY BILL P. STARK, *Department of Biology, University of Utah, Salt Lake City, Utah.*

Each of seven Nearctic Acroneurine genera are characterized in terms of male tergal modifications, male hammer, male aedeagus, ovum, nymphal head and pronotum, and nymphal cerci. These data support Illies (1966) elevation of *Attaneuria, Beloneuria, Doroneuria, Eccoptura* and *Hesperoperla* to generic status, and the recent (Stark and Gaufin, 1974) removal of *Calineuria* from the synonymy of *Doroneuria.* The restricted definition of *Acroneuria* emphasizes the need for careful study of Oriental material currently placed in that genus.

The male aedeagus and female ovum are shown to have highly diagnostic characters for species recognition in *Acroneuria, Neoperla* and *Paragnetina.*

## THE *ISOPERLA* OF TEXAS.

BY STAN W. SZCZYTKO, *Department of Biology, North Texas State University, Denton, Texas.*

The distribution of Plecoptera within the state of Texas was studied. Three species of *Isoperla* were found east of the Blackland Prairie, and specimens collected by J. A. and H. H. Ross in 1939 from El Paso were examined.

The four species consisted of *I. mohri* Frison 1935, two new species, and the El Paso specimens identified by Frison (1942) with some hesitation as *I. longiseta* Banks 1906, which appears to be a new species.

Collections of *Isoperla* from the adjacent states of Oklahoma and Louisiana were also examined. Six species were determined in all, including *I. clio*, *I. mohri*, *I. namata*, *I. longiseta* and what appears to be two new species.

The lacinia, mandibles, and labium were used for separating the nymphs, and the aedeagus and subgenital plate were used for separating males and females respectively.

## NOTONEMOURIDAE—SYSTEMATICS AND DISTRIBUTION.

BY JOACHIM ILLIES, *Limnologische Flußstation des Max-Planck-Instituts für Limnologie, Germany.*

The taxonomy and distribution of the Notonemouridae are discussed with an emphasis on the fauna of the Australian region.

## THE FAMILY NEMOURIDAE.

BY RICHARD W. BAUMANN, *Department of Entomology, Smithsonian Institution, Washington, D.C.*

The present taxonomic state of the family is reviewed at the generic level. The 13 recognized genera are characterized and the useful characters described and explained. A preliminary phylogenetic diagram is presented showing the basic relationships of the genera to each other in the famly Nemouridae. The distribution of the family is discussed and noted to be Holarctic and Oriental.

## AFRICAN SPECIES OF THE GENUS *NEOPERLA* NEEDHAM (PERLIDAE).

BY PETER ZWICK, *Limnologische Flußstation des Max-Planck-Instituts für Limnologie, Germany.*

African *Neoperla* were supposed to belong to a single very variable species by Hynes (1952) and Illies (1966), who together synonymized

29 nominal species under one name. However, instead of the one and only *Neoperla spio* (Newman), there is a multitude of segregates. It has been shown before (Zwick, 1972, 1973), that these are not variants, but are specifically distinct. External genitalia, shape of penis and denticulation of the inner membranous sac need to be studied for reliable distinction of ♂♂. Shape and pattern of sternite 8, shape and denticulation of the vagina and receptacular base, and particularly the shape and structures of eggs provide specific characters in ♀♀. As genital characters alone are distinctive, it is easy to sort to species each sex separately, but it is not normally possible to associate sexes. This seriously hampers a revision of the African *Neoperla.*

Several species groups are distinguished, some were discussed in detail. It is as yet uncertain whether all morphological segregates are of specific or intraspecific rank. There are more than 10 species, possibly as many as 25 or even more. Most of them are very widely distributed in Africa.

### Literature Cited

Hynes, H. B. N. 1952. The Neoperlinae of the Ethiopian region (Plecoptera, Perlidae). Trans. R. Ent. Soc. Lond. 103:85–108.

Illies, J. 1966. Katalog der Rezenten Plecoptera. Das Tierreich, 82: I–XXX, 1–631 (Berlin).

Zwick, P. 1972. Notes on African *Neoperla* (Ins., Plecoptera). 14 Internat. Congr. Entomol. Abstracts: 102.

———. 1973. Entomological explorations in Ghana by Dr. Endrody-Younga, 27. Notes on some species of *Neoperla* (Plecoptera). Fol. Ent. Hung. 26 (Suppl.):381–398 (Budapest).

## MATING BEHAVIOR OF *PARAGNETINA FUMOSA*, *PERLINELLA DRYMO* AND *HYDROPERLA CROSBYI*; WITH SPECIAL EMPHASIS ON EXTERNAL SPERM TRANSFER IN *H. CROSBYI.*

by Kenneth W. Stewart, *North Texas State University, Denton, Texas, USA.*

Virgin adult *Paragnetina fumosa* (Banks), *Perlinella drymo* (Newman) and *Hydroperla crosbyi* (Needham & Claassen) were paired in small plexiglass and glass chambers of various sizes. Super-8 mm cinema photographs and microscopic examination of mating pairs revealed species-specific variations in behavior in all 3 species, and an unreported method of external sperm transfer in *H. crosbyi.* Both males and females of *P. fumosa* and *P. drymo* engaged in drumming prior to mating. Capture involved a mere crawling onto the female by male *P. drymo,* but *P. fumosa* males assumed a distinctive "arched-body" posture during capture and an oblique "head-in-the-air" position during mating. Duration of copulation in both species was ca. 1 hr.

Neither sex of *H. crosbyi* drummed; the male crawled onto the female, assuming a typical superposition, then curved his abdomen around either the left or right side to engage the female subgenital plate with his genital hooks. The subgenital plate was pulled down and action by the accessory external genitalia, primarily the epiproct, resulted in formation of a depression or "sperm pocket" beneath it. Then followed a spontaneous eversion of the membranous male aedeagus, transfer of the sperm mass to the pre-formed "pocket," retraction of the aedeagus, and finally a curious tapping or brushing action by the male cerci on the female cerci. The latter served as a releaser for initiating telescoping contractions of the apical female abdominal segments, resulting in sperm aspiration. Sperm transfer was therefore external, with no copulation. All three species were polygamous.

## AN EMERGENCE SEQUENCE OF CHLOROPERLIDAE IN A NORTHEASTERN OHIO STREAM.

BY MARTIN A. TKAC, JR., *Department of Biological Sciences, Kent State University, Kent, Ohio.*

The family Chloroperlidae is well represented in a small isolated stream habitat in northeastern Ohio. This stream flows through a unique, vertical-walled habitat within a dense mixed forest of northern hardwoods and hemlock. The gorge, Stebbins Gulch, has been incised into sandstones and shales to a depth in excess of three hundred feet, creating a relict habitat that is quite different from other stream habitats in northeastern Ohio.

Chloroperlidae present in this stream habitat include three genera and some five species. The species present and emergent periods are: *Alloperla caudata* Frison, May 27–July 29; *A. chloris* Frison, June 18–August 24; *A. imbecilla* (Say), May 20–June 4; *Hastaperla brevis* (Banks), May 20–July 1; and *Sweltsa onkos* (Ricker), May 20-June 18. Thus emergence commences with three species representing all three genera present in the area by May 20 and continues uninterruptedly until as late as August 24, with *Alloperla chloris* terminating the emergence of the family from the stream.

## EMERGENCE PATTERNS IN PLECOPTERA.

BY PETER P. HARPER, *Département des Sciences Biologiques, Université de Montréal, Québec, Canada.*

Emergence patterns in Plecoptera are discussed on the basis of data collected in 1972–1974 on the L'Achigan River in Quebec. Fifty emergence trap series were analysed from twenty-eight sites on the mainstream and from seventeen sites on six tributary streams.

Because of the relatively long adult life span of stoneflies, only data from emergence traps (or other means of collecting teneral adults) can be used to draw emergence patterns. General collecting and light-trap catches provide a biased picture of the emergence.

Emergence sequence indicates some temporal spacing between species, but closely related species often emerge at the same time and in the same places.

Emergence patterns for a given species are similar from year to year; the differences observed seem to be related to particular climatic conditions.

The emergence is alike in adjacent sites and is affected in a similar manner by the short-term climatic variations.

Two types of patterns can be distinguished, viz a short synchronous emergence and a longer gradual emergence. Though these are often easily separable, it is not yet clear whether they represent a basic characteristic of the species concerned or whether they are imposed by local climatic conditions. More data from various climatic regions is needed before this can be determined.

The numbers of species and specimens collected in the traps vary considerably from site to site and from year to year; this is probably explained by the great heterogeneity of the stream studied.

## THE STRUCTURE (ULTRA) AND FUNCTION OF THE VENTRAL LOBE AND THE HAMMER OF PLECOPTERA.

BY RAINER RUPPRECHT, *Zoological Institute, Johannes Gutenberg University, Mainz, Germany.*

The fine structure of the vesicle of *Leuctra* and *Capnia* and of the hammer of *Isoperla* are described. There are bristles on the vesicle and beyond the edge of the hammer, which are innervated by a single bipolar sensory cell. The existence of a tubular body in the outer dendritic segment shows that this hair is mechano-receptive. The functions of these organs are understood by observation during use and by elimination of the hair on these organs. The vesicle (or ventral lobe) is a sternal protrusion covered with hair, giving the animal a feedback that it has touched the ground, and permitting it to conrol the drumming position. It is a tactile organ. The hammer is a protrusion or extension of one or more sterna (7 to 9), which is used for tapping. It is covered by hair which has the same function as the hair on the vesicle. The hammer is a tapping organ.

## THE STONEFLIES (PLECOPTERA) OF THE ROCKY MOUNTAINS.

BY ARDEN R. GAUFIN, *Department of Biology, University of Utah, Salt Lake City, Utah.*

During the last 20 years the author and his associates at the University of Utah, and University of Montana Biological Station have conducted

numerous studies to determine the taxonomy distribution, and ecology of the stoneflies of the Rocky Mountains of western North America.

The Rocky Mountains can be divided into two fairly well defined zones. The Northern Rocky Mountain zone includes the higher areas of British Columbia and Alberta, Canada, most of Montana, central Idaho, and the northwestern part of Wyoming. The extreme eastern section of Oregon and southeast Washington can also be included in this area and it contains typical Rocky Mountain species. The Southern Rocky Mountains are divided by the Colorado River, and associated high arid plateau areas, into the Wasatch area and the Colorado Rockies. The Wasatch area includes the Wasatch and Uinta Mountains of northern Utah, the Wasatch Plateau and other mountains of south central Utah, and the Green River drainage of southwest Wyoming. The Southern Rocky Mountain zone as such includes the mountains of south central Wyoming, all the mountains of Colorado, the mountains of New Mexico, and the mountains of Arizona.

The lowlands of the western states constitute distinct barriers to stonefly dispersal. The lack of cool clean streams in the lowlands presents barriers that have isolated many forms. Mountain ranges are the main routes of dispersal for the different groups. The two great barriers to movement are the Great Plains and the Great Basin. The Great Plains have completely blocked the eastern movement of the family Capniidae. The few western *Capnia* that are found in the Northeast have presumably dispersed across northern Canada, possibly during the cooler glacial periods. Several smaller barriers are the Snake River Plains area of the Columbia Plateau; the Colorado River, and the lowlands of eastern Washington, Oregon, and Nevada. The zones isolated by these barriers are usually mountain ranges or elevated areas with abundant precipitation.

## Distribution of Stoneflies in Rocky Mountains

One of the principal objectives of the research that has been conducted has been to assemble data for a publication entitled, "The Stoneflies (Plecoptera) of the Rocky Mountains." It will include descriptions, keys, illustrations, and ecological data for the various species of stoneflies found in the region. It is anticipated that this bulletin will be ready for publication within the next year.

During the course of the research, records or specimens of 165 species of stoneflies from the Rocky Mountains have been collected (Table 1). Of these the most common families have been the Capniidae represented by 47 species, Chloroperlidae, 28 species, and Nemouridae, 24 species.

Montana and Idaho have yielded the most species with 119 and 101 species respectively. This may partly reflect the more intensive collecting that has been done in Montana particularly.

Of the 165 species, two, *Hesperoperla pacifica* and *Malenka californica*, have been collected in all ten of the provinces or states col-

TABLE 1. Stoneflies of the Rocky Mountains.

| Family | No. Genera | No. Species |
|---|---|---|
| Pteronarcidae | 2 | 5 |
| Peltoperlidae | 1 | 2 |
| Perlodinae | 10 | 18 |
| Isoperlinae | 1 | 14 |
| Perlidae | 8 | 9 |
| Chloroperlidae | 8 | 28 |
| Taeniopterygidae | 4 | 7 |
| Nemouridae | 9 | 24 |
| Capniidae | 6 | 47 |
| Leuctridae | 4 | 11 |
| | 53 | 165 |

lected. An additional six species, *Pteronarcella badia, Isogenoides elongatus, Skwala parallela, Claassenia sabulosa, Sweltsa borealis,* and *Sweltsa coloradensis,* have been collected in nine provinces or states. By contrast 17 species have been collected in only one or two of the provinces or states respectively. Several of these rarer species are common in other sections of the United States such as *Pteronarcys dorsata, Isoperla trictura, Acroneuria internata,* and *Perlesta placida.* Others such as *Alloperla pilosa, Lednia tumana, Capnia spenceri* and *Nemoura arctica* have been taken in only one or two areas.

Of the various sections of the Rocky Mountains collected Glacier National Park has been most productive. Seventy-three species of stoneflies have been collected from the park, including several species which have yet to be described. Specimens have been collected from practically every conceivable aquatic habitat including seeps, ponds, waterfalls, torrential and slow moving streams and lakes. Adults have been taken at all seasons of the year; and, fall, winter, spring and summer emergents have all been collected within the confines of the park from mid-June through mid-August. Species which normally emerge in February and March at lower altitudes, 400 miles southward have been collected emerging in large numbers from snow-fed lakes and streams during midsummer. Eighteen species have been collected from lakes, a habitat which normally supports very few species of stoneflies in other regions of the country. Stoneflies more representative and common to the Pacific Coast, the southern Rockies, the Great Plains, the Arctic, and the high plateaus are intermixed, presenting an unusual diversity of stoneflies and very interesting ecological problems.

## PRELIMINARY STUDIES ON PENNSYLVANIA STONEFLIES.

BY REBECCA F. SURDICK, *Department of Entomology, Pennsylvania State University, University Park, Pennsylvania.*

Little work has been done on the taxonomy and natural history of Plecoptera in Pennsylvania. However, numerous mountain watersheds and lowland streams and rivers in the state provide excellent habitat for a varied and abundant stonefly fauna. The present study, involving an examination of various collections and literature records, resulted in a list of 79 species comprising 32 genera. Thus, over half of the genera and nearly half of the species whose geographical range includes the eastern United States were found in Pennsylvania. Identification keys were constructed for the nymphs of the families Perlidae, Perlodidae and Pteronarcidae. The information obtained will facilitate the identification of Plecoptera in taxonomic and ecological studies, pollution investigations and stream surveys and provide a baseline list of species that may be found in Pennsylvania watercourses. More extensive and intensive collecting in the future is expected to yield undescribed species and reveal new state records.

## BIOGEOGRAPHY OF NEW ZEALAND PLECOPTERA.

BY IAN D. MCLELLAN, *Westport, New Zealand.*

For a better understanding of the discussion on the possible origins of New Zealand's present stonefly fauna the following summary of its geological and climatic history is given.

New Zealand was a trough in the sea floor adjacent to Australia and Antarctica at the end of the Palaeozoic. The trough became filled in and New Zealand appeared around Late Jurassic–Early Cretaceous. By this time the Tasman Sea was forming and, as drift occurred, the gap became considerable between New Zealand and the rest of Gondwanaland. This drift continued and now New Zealand is 1800 km from Australia and 2500 km from Antarctica. When first formed, New Zealand was mountainous with a temperate climate but by Late Cretaceous the land was eroded to almost sea level and the climate sub-tropical. This low lying land persisted with a sub-tropical–tropical climate until mountain building and cooling of climate occurred in the Miocene. This mountain building is still continuing.

Colonisation by stoneflies by land could have occurred but this would mean isolation for 130 million years with unfavourable conditions from Upper Cretaceous to Upper Miocene. An alternative is arrival by wind drift. In recent years there are many records of Australian insects and birds crossing by this method and successfully invading new biotopes made available by man's activities. This must have occurred in the past when niches became available as topography and climate changed. It has been calculated that suitable drift conditions occur 20–30 days

a year, spread throughout the year. How does this fit in with what is known about the New Zealand stoneflies?

First, with the largest group, the gripopterygids, we find a closely related group of genera with a common feature (lack of tibial spurs) not found as such in other gripopterygid groups. Therefore, they must be derived from a single species or group of closely related species. If they arrived 130 million years ago surely there would have been greater differences. This lack of difference could be explained by saying that one species survived the unfavourable conditions until the Upper Miocene when speciation was made possible in more favourable biotopes. If arrival was not by land the most obvious course is by wind drift from Australia from the Upper Miocene onwards. This would account for the close relationship of genera.

The two methods of invasion are also possible for the Antarctoperlinae. However, this subfamily is found only in New Zealand and South America. These two land masses were divided by Antarctica so that it is only possible for them to have arrived via Australia where they must have become extinct at a later time.

The notonemourids can be divided into two groups, the Notonemoura group and the Spaniocerca-Spaniocercoides group. The Notonemoura group has very close relatives in Australia (included in the same genus) and would be a wind drift invader at or after the end of the Pleistocene. The Spaniocerca-Spaniocercoides group consists of forms which differ from their Australian counterparts to a greater degree and are probably pre-Pleistocene.

The remaining two stoneflies *Stenoperla prasina* (Eustheniidae) and *Austroperla cyrene* (Austroperlidae) both have very closely related forms in Australia and are obviously recent invaders by wind drift.

Within New Zealand there is only one endemic found in the North Island but there is considerable endemism in the south with restricted species existing in those areas considered to be Pleistocene refugia. Many of the endemics are found in alpine biotopes. Many of the gripopterygids and antarctoperlinids are wingless and a number of their larvae are terrestrial. The alpine notonemourids have not changed greatly. They have very similar sister species in the lowlands or are forms of lowland species. One point which must be remembered in relation to alpine stoneflies is that New Zealand's alpine biota is not older than Upper Miocene.

## A PRELIMINARY REPORT OF THE PLECOPTERA FAUNA IN BOSNIA AND HERZEGOVINA (YUGOSLAVIA).

BY DRAGICA KAĆANSKI, *Bioloski Institut Univerziteta, Sarajevo, Yugoslavia.*

The faunistical survey of Plecoptera from Bosnia and Herzegovina, which according to ILLIES' classification of the European limnofauna (1967) is situated within the limits of the western Balkan region, is based

TABLE 2. List of Plecoptera species. B = drainage area of the river Bosna. D = drainage area of the river Drina. N = drainage area of the river Neretva (middle reaches). L = running waters in southwestern Bosnia (environments of Livno). O = other localities.

| | B | D | N | L | O |
|---|---|---|---|---|---|
| Taeniopterygidae | | | | | |
| Brachyptera graeca BERTHELEMY | + | + | + | | |
| helenica AUBERT | | + | + | | |
| risi (MORTON) | + | + | | | + |
| seticornis (KLAPALEK) | + | + | | | + |
| tristis (KLAPALEK) | + | + | + | + | + |
| Taeniopteryx auberti KIS and SOWA | + | | | | |
| hubaulti AUBERT | | | | | + |
| schoenemundi (MERTENS) | | + | | | |
| Nemouridae | | | | | |
| Protonemura auberti ILLIES | + | + | | + | + |
| autumnalis RAUSER | + | + | | | |
| hrabei RAUSER | + | + | | | |
| intricata RIS | + | + | + | | + |
| praecox (MORTON) | + | + | | | |
| Amphinemura standfussi RIS | + | + | | | + |
| sulcicollis STEPHENS | + | + | | | + |
| triangularis RIS | + | + | + | | + |
| Nemoura avicularis MORTON | | | | | + |
| cambrica (STEPHENS) | | + | | | |
| cinerea (RETZIUS) | + | + | | + | + |
| dubitans MORTON | + | | | | |
| flexuosa AUBERT | + | + | | | |
| fulviceps KLAPALEK | + | + | | | |
| marginata PICTET | + | + | | | + |
| minima AUBERT | + | | | | |
| subtilis KLAPALEK | | + | | | |
| Nemurella picteti KLAPALEK | + | + | | | |
| Leuctridae | | | | | |
| Leuctra albida KEMPNY | + | + | | | |
| aptera KACANSKI and ZWICK | | + | | | |
| bronislavi SOWA | + | + | | | |
| cinqulata KEMPNY | + | + | + | | |
| digitata KEMPNY | + | + | | | |
| fusca (LINNAEUS) | + | + | + | | |
| handlirschi KEMPNY | + | + | | | |
| hippopoides KACANSKI and ZWICK | + | + | | | + |
| hippopus KEMPNY | + | + | | | + |
| hirsuta BOGOESCO and TABACARU | + | + | | | |

TABLE 2. (con't).

| | B | D | N | L | O |
|---|---|---|---|---|---|
| inermis KEMPNY | + | + | | | |
| major BRINCK | + | + | | | |
| mortoni KEMPNY | + | + | | | |
| nigra (OLIVIER) | + | + | | | + |
| olympia AUBERT | | + | + | | |
| prima KEMPNY | + | + | | | |
| pseudosignifera AUBERT | + | + | | | |
| quadrimaculata KIS | + | + | | | + |
| rosinae KEMPNY | | + | | | |
| signifera jahorinensis KACANSKI | + | + | | | |
| Capniidae | | | | | |
| Capnia vidua (PICTET) | | + | | | |
| Capnopsis schilleri (ROSTOCK) | + | | | | |
| Perlodidae | | | | | |
| Arcynopteryx compacta MACLACHLAN | | + | | | |
| Besdolus imhoffi (PICTET) | | | | | + |
| Dyctiogenus fontium RIS | | | | + | |
| Perlodes jurassica AUBERT | | | | | + |
| intricata (PICTET) | + | | | | |
| microcephala (PICTET) | + | + | | | + |
| Isoperla albanica AUBERT | + | + | | | + |
| buresi RAUSER | + | + | | | + |
| graeca AUBERT | + | + | | | + |
| grammatica (PODA) | + | | | | |
| inermis KACANSKI and ZWICK | | | + | | + |
| oxylepis (DESPAX) | + | + | + | | + |
| tripartita ILLIES | + | + | | | |
| Perlidae | | | | | |
| Dinocras megacephala (KLAPALEK) | + | + | + | | |
| Perla bipunctata PICTET | | + | | | |
| burmeisteriana CLAASSEN | + | + | | | + |
| illiesi BRAASCH and JOOST | | | | | + |
| marginata (PANZER) | + | + | + | | + |
| pallida GUERIN | | | + | | |
| Chloroperlidae | | | | | |
| Siphonoperla montana (PICTET) | + | | | | + |
| neglecta (ROSTOCK) | + | + | | | + |
| neglecta graeca (AUBERT) | | + | | | |
| transsylvanica (KIS) | + | + | | | ?+ |
| Chloroperla russevi BRAASCH | + | + | | | |
| tripunctata (SCOPOLI) | | + | + | | + |

on material collected since 1958, with the most intensive collecting occurring after 1966.

Adult Plecoptera were collected mostly in the drainages of the Bosna and Drina rivers, in the middle reaches of the Neretva River, in Karst streams of southwestern Bosnia (in the environs of Livno) and from time to time from other localities throughout Bosnia and Herzegovina.

The identification of the collected Plecoptera resulted in 73 species and subspecies (Table 2).

The list of Plecoptera obtained reveals a great variety of zoogeographical elements.

Among the established stoneflies, 3 species (*Leuctra aptera, L. hippopoides, Isoperla inermis*) and a subspecies (*L. signifera jahorinensis*) occur only in the Dinaric ranges.

Five species are found both in the Dinaric ranges and the Carpathian Mountains: *Taeniopteryx auberti, Protonemura autumnalis, Leuctra bronislavi, L. quadrimaculata* and *Siphonoperla transsylvanica.*

Eight species, *Brachyptera graeca, B. helenica, B. tristis, Leuctra olympia, Isoperla albanica, Perla illiesi, Siphonoperla neglecta graeca, Chloroperla russevi,* are restricted to the Balkan region. Four species: *Nemoura subtilis, Leuctra hirsuta, Isoperla buresi* and *I. graeca* occur only in southeastern Europe.

Worthy of note is the finding of 3 species whose center of distribution is the Alps: (*Nemoura minima, Dyctiogenus fontium, Siphonoperla montana*). The bulk of the remaining species (20) are common to Central Europe.

## AUTOHEMORRHAGE IN TWO STONEFLIES AND ITS EFFECTIVENESS AS A DEFENSE MECHANISM.

BY ERNEST F. BENFIELD, *Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.*

When subjected to traumatizing stimuli, adults of the stoneflies *Pteronarcys proteus* Newman and *Peltoperla maria* Needham and Smith autohemorrhage at the intersegmental membranes of the coxial and tibiofemoral joints of the legs. Autohemorrhage reactions can be somewhat localized when local stimuli are applied, e.g. if one leg is traumatized, bleeding occurs at that leg. However, a more general stimulus, e.g. grasping the animal's trunk, elicits a response at most or all of the legs.

Autohemorrhage in both stoneflies is an effective defensive mechanism against certain ants. In *Pteronarcys,* autohemorrhage is often of an "explosive" nature in that the hemolymph is forcibly expelled with droplets carrying up to 10 inches from the animal. The "explosive autohemorrhage" of *Pteronarcys* is accompanied by an audible popping sound which, in combination with the hemolymph droplets, was shown to delay attack by a vertebrate predator.

## ASPECTS OF THE MORPHOLOGY AND FUNCTIONS OF TRACHEAL GILLS OF SOME PLECOPTERAN NYMPHS.

BY NARINDER N. KAPOOR, *Department of Biology, Loyola College, Montreal, Canada.*

Nymphs of some Plecoptera possess cuticular filamentous gills on different parts of the body. These gills occur as lateral tufts on each thoracic segment of the *Paragnetina media.* A closely related species, *Phasganophora capitata* has an additional pair of anal gills. The nymphs of the family Eustheniidae have 5–6 pairs of gills on the abdomen.

Experimental studies showed that *Paragnetina* could not survive without gills and there was a considerable reduction (70–78%) in oxygen uptake when gills were removed (Kapoor 1974a).

The scanning and transmission electron microscope studies revealed fascinating structures and associated cells on the gills. Cuticular discs are distributed profusely on the proximal portion of the gills of *Phasganophora* and *Paragnetina.* A large number of hairs are interspersed among the discs of *Phasganophora.* The disc is part of a highly specialized bag shaped 'Osmoregulatory cell' (Kapoor and Zachariah, 1973; Kapoor 1974b).

On the finger-like abdominal gills of eustheniids are found flower bud-like structures and few cuticular hairs. These structures are probably sensory in function since each structure is associated with a bipolar neuron. Wichard and Komnick (1974) have provided histochemical evidence to show that similar bulbiform structures in the integument of *Protonemura* are probably involved with the absorption of chloride ions.

### LITERATURE CITED

KAPOOR, N. N. 1974a. Some studies on the respiration of stonefly nymph, *Paragnetina media* (Walker). Hydrobiol. 44:37–41.

———. 1974b. Special morphological features of gills in Plecoptera. Proc. Microsc. Soc. Canada 1:66–67.

KAPOOR, N. N. AND K. ZACHARIAH. 1973. A study of specialized cells of the tracheal gills of *Paragnetina media* (Plecoptera). Can. Jour. Zool. 51:983–986.

WICHARD, W. AND H. KOMNICK. 1974. Fine structural and histochemical evidence of chloride cells in stonefly larvae. 2. The caviform and buliform chloride cells. Cytobiologie 8:297–311.

## NOTES ON THE FAMILY SCOPURIDAE.

BY TEIZI KAWAI, *Zoological Institute, Nara Women's University, Nara, Japan.*

Since the establishment of the family Scopuridae in 1935, it has been considered monospecific with only the remarkable species *Scopura longa*

Fig. 8. Map indicating the geographical distribution of *Scopura longa* Uéno and *Scopura*, n. sp. ●, *Scopura longa*; ○, *Scopura* n. sp. 1. Type-locality of *S. longa*, middle of July, 1925, Towada Lake, by M. Uéno and T. Kawamura. 2. Locality at which male of *S. longa* was found for first time, 28 Sept. 1928, Takeishi Pass, Nagano Pref., by H. Kiyosawa. 3. Locality at which female of *S. longa* was found for first time, 13 July 1936, Hakuun Fall, Nikko, by M. Kohno. 4. Type-locality of *Scopura* n. sp., 12 Nov. 1972, Mt. Myoken, Is. Sado, by S. Uéno.

Uéno, 1929. However, having examined some interesting specimens of *Scopura* from the Island of Sado which lies in the Sea of Japan, circa 45 km from Niigata, I have reached the conclusion that they should be separated from *Scopura longa* as a new species. This new form is to be called *Scopura* n. sp. Its present records of distribution are restricted to the Island of Sado and a portion of the North Kanto District (Ibaragi Pref.).

As far as has been known, more than 350 localities have been reported from Honshu and Hokkaido as well as Korea by Komatsu (1970). All of them are those of *Scopura longa* and most of them are the records of nymphs. The geographical distribution of the imagines of the two species in question is shown in Figure 8. Both species are usually found

in cold water streams or the adjacent hygroscopic places where the temperature of the water is lower than 10°C in midsummer. The family seems, therefore, to be a typical boreo-alpine inhabitant, capable of living either in the hygroscopic places such as mosses and fallen leaves or on the wet trunks of trees.

### Literature Cited

Kawai, T. 1974. The second species of the genus *Scopura* (Plecoptera, Scopuridae). Bull. Natur. Sci. Mus. Tokyo. (in press).

Komatsu, T. 1970. Localities of *Scopura longa* Uéno (Plecoptera) in Japan and Korea (in Japanese). New Ins. 14:14–28.

## DISTRIBUTION OF STONEFLIES (PLECOPTERA) WITHIN THE HUBBARD BROOK WATERSHED, NEW HAMPSHIRE.

by Samuel M. Fiance, *Department of Entomology, Cornell University, Ithaca, New York.*

Preliminary distributions of ten species of stoneflies were based on collections during spring and summer of 1974. *Allonarcys biloba*, *Peltoperla maria*, and *Leuctra tenuis* have riverine distributions. The distributions of *Sweltsa lateralis*, *Sweltsa mediana*, *Leuctra tenella*, *Leuctra ferruginea* and *Amphinemura wui* are limited only by the extent of permanently flowing waters. *Leuctra duplicata* and *Ostrocerca albidipennis* were found in temporary as well as permanently flowing waters.

Substrate conditions appear to be correlated with distribution of *Allonarcys biloba* which was found associated with large boulders and swiftly flowing waters.

In addition to the species listed above, *Alloperla chloris*, *Hastaperla brevis*, *Paranemoura perfecta* and *Paracapnia angulata* also were recorded from the Hubbard Brook Watershed. It appears that some of these species are unrecorded from New Hampshire.

### Symposium Registrants

| | |
|---|---|
| Baumann, Dr. R. W. | Department of Entomology, Smithsonian Institution, Washington, D.C. 20560 USA |
| Benfield, Dr. E. F. | Department of Biology, VPI and SU, Blacksburg, Virginia 24061 USA |
| Berg, Dr. C. O. | Department of Entomology, Cornell University, Ithaca, New York 14850 USA |
| Bode, R. W. | Environmental Health Center, N.Y. State Dept. Health, New Scotland Avenue, Albany, New York 12201 USA |

| | |
|---|---|
| Fiance, S. M. | Department of Entomology, Cornell University Ithaca, New York 14850 USA |
| Flint, Dr. O. S., Jr. | Department of Entomology, Smithsonian Institution, Washington, D.C. 20560 USA |
| Gaufin, Dr. A. R. | Department of Biology, University of Utah, Salt Lake City, Utah 84112 USA |
| Harper, Dr. P. P. | Department of Biological Sciences, University of Montreal, Montreal 101, Quebec, C.P. 6128, Canada |
| Illies, Dr. J. | Max-Planck Limnology Institute, Box 260, 6407 Schlitz, West Germany |
| Kaćanski, Dr. D. | University Biological Institute, M. Tita 114, Box 12, 71000 Sarajevo, Yugoslavia |
| Kapoor, Dr. N. N. | Department of Biology, Loyola College, Montreal 262, Quebec, Canada |
| Kawai, Dr. T. | Zoological Institute, Nara Women's University, Nara, Japan |
| Kirchner, R. F. | Box 382, Holden, West Virginia 25625 USA |
| Kohno, Dr. M. | T̄965.1–15 Ôhatamachi Aizu-Wakamatsu City, Fukushima Prefecture, Japan |
| McElravy, E. P. | Department of Biological Sciences, Kent State University, Kent, Ohio 44242 USA |
| McLellan, I. D. | Box 95, Westport, New Zealand |
| Nelson, Dr. C. H. | Department of Biology, University of Tennessee, Chattanooga, Tennessee 37401 USA |
| Oblad, B. R. | NUS Corporation, 2419 Baldwick Road, Pittsburgh, Pennsylvania 15205 |
| Ricker, Dr. W. E. | 3052 Hammond Bay Road, Nanaimo, British Columbia V9T-1E2, Canada |
| Rupprecht, Dr. R. | Zoological Institute, Johannes Gutenberg University, Saarstrasse 21, 6500 Mainz, West Germany |
| Smolka, J. V. | Department of Biological Sciences, Kent State University, Kent, Ohio 44242 USA |

| | |
|---|---|
| Smrchek, D. R. | 3316 King William Drive, Olney, Maryland 20832 USA |
| Spangler, Dr. P. J. | Department of Entomology, Smithsonian Institution, Washington, D.C. 20560 USA |
| Stark, Dr. B. P. | 634 Elwood, Irving, Texas 75061 USA |
| Stewart, Dr. K. W. | Department of Biological Sciences, North Texas State University, Denton, Texas 76203 USA |
| Surdick, R. F. | Department of Biology, University of Utah, Salt Lake City, Utah 84112 USA |
| Sykora, Dr. J. | Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania 15261 USA |
| Szczytko, S. W. | Department of Biological Sciences, North Texas State University, Denton, Texas 76203 USA |
| Tarter, Dr. D. C. | Department of Biological Sciences, Marshall University, Huntington, West Virginia 25701 USA |
| Tkac, M. A., Jr. | Department of Biological Sciences, Kent State University, Kent, Ohio 44242 USA |
| Tolbert, V. R. | Graduate Program in Ecology, University of Tennessee, Knoxville, Tennessee 37916 USA |
| Watkins, W. D. | Department of Biological Sciences, Marshall University, Huntington, West Virginia 25701 USA |
| Woolman, H. N., III | Foxridge Fur and Feathers, The Plains, Virginia 22171 USA |
| Zeigler, D. D. | Department of Biological Sciences, North Texas State University, Denton, Texas 76203 USA |
| Zwick, Dr. P. | Max-Planck Limnology Institute, Box 260, 6407 Schlitz, West Germany |

QH
1
B4X
NH

o. 39, pp. 429–432 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES

# *PARAMETOPELLA INQUILINUS*, NEW SPECIES FROM DELAWARE BAY OYSTER BEDS (AMPHIPODA: STENOTHOIDAE)

BY LES WATLING
*College of Marine Studies, University of Delaware, Lewes, Delaware 19958*

The genus *Parametopella* is, at present, characterized by the following features (Barnard, 1969): linear article 2 of pereopods 4 and 5; uniarticulate palp of maxilla 1; mandible without palp. To date, only three species in this genus are known: *P. stelleri* Gurjanova from the Russian Arctic, *P. ninis* Barnard from southern California, and *P. cypris* (Holmes) from northeastern North America. This paper describes a new species of *Parametopella* from the polyhaline waters of Delaware Bay, U.S.A.

STENOTHOIDAE

*Parametopella* Gurjanova, 1938

**Parametopella inquilinus**, new species

Figures 1–2

*Diagnosis*: Antenna 1, peduncle segments 1 and 2 subequal in length; gnathopod 2 powerful, palm with large teeth near hinge, excavate posteriorly with strong tooth on posterior corner; coxal plate 4 greatly expanded covering coxae 3 through 7.

*Description of male*: length 3.0 mm. Head small, interantennal angle rounded. Antennae about ⅓ length of body.

Antenna 1 peduncle article 1 stout, wider than article 2; articles 1 and 2 of subequal length; article 3 about ¼ length of article 2. Antenna 2 peduncle nearly as long as antenna 1; last 2 peduncle articles subequal in length; flagellum of 4 to 6 segments.

Mouthparts typical for genus. Mandible without palp; maxilla 1 palp uniarticulate; maxilliped outer plate vestigial, inner plate small, sparsely setose, palp with few, strong setae.

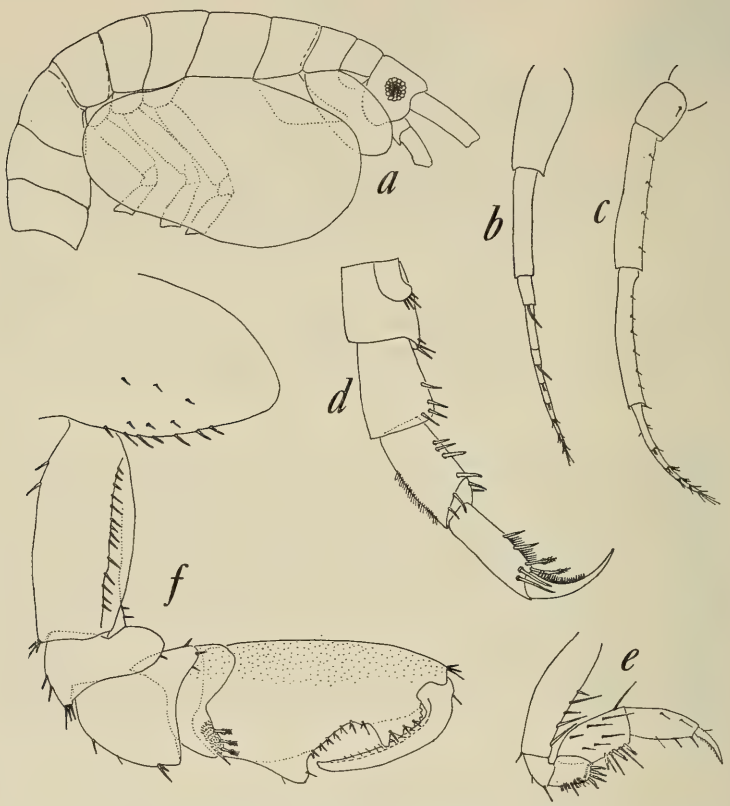



FIG. 1. *Parametopella inquilinus*, new species: a, Side view of body; b, Antenna 1; c, Antenna 2; d, Third maxilliped; e, Male gnathopod 1; f, Male gnathopod 2.

Gnathopod 1 simple; dactyl finely pectinate; propodus with 3 setae on posterior margin; article 5 equal in length to article 6, posterior margin with 3 groups of strong, pectinate setae; distal margin of article 4 with cluster of pectinate setae and group of short spines; article 2 with anterior row of long, simple setae.

Gnathopod 2 strong; palm of propodus strongly excavate between distal group of teeth and large proximal tooth; article 5 with cluster of pectinate setae on postero-distal corner; article 3 with thin, transparent, anteriorly-directed projection; article 2 armed with anterior row of short, simple setae; coxal plate large, not covered distally by coxal plate 4, lower margin with several short spines.

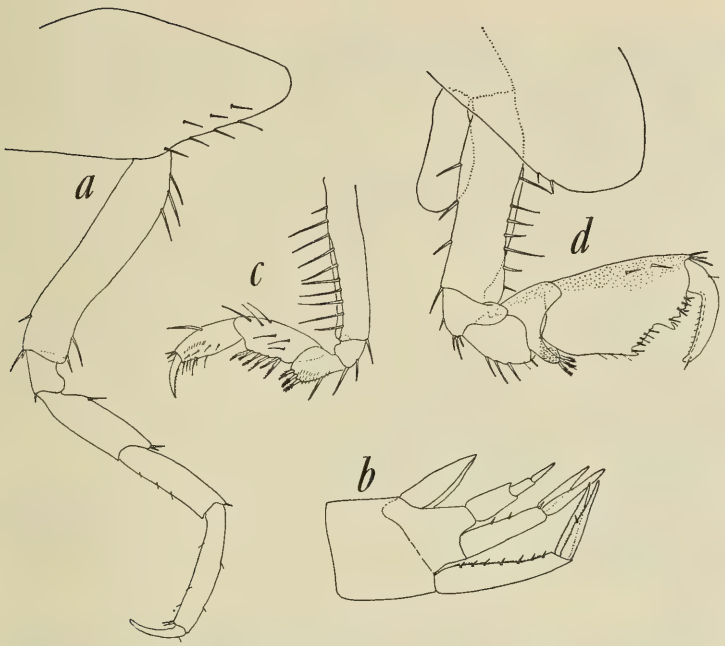



FIG. 2. *Parametopella inquilinus*, new species: a, Pereopod 1; b, Urosome; c, Female gnathopod 1; d, Female gnathopod 2.

Pereopod 3 coxal plate short, sharply tapered anteriorly, lower margin lightly armed along anterior portion; article 2 with 3 proximal and 2 distal spines along anterior margin; appendage notable for its lack of setation. Pereopod 4, coxal plate large, extending anteriorly to overlap slightly coxal plate 2 and posteriorly to cover coxal plate 7. Pereopods 5–7, article 2 slender.

Urosome segments 2 and 3 fused; uropod 1 outer ramus with single spine, peduncle with 7 spines; uropod 2, peduncle with 2 dorsal and single distal spine, rami without spines; uropod 3 uniramous, unarmed, two segments of ramus equal in length to peduncle. Telson entire, without spines.

*Female*: Similar to male; gnathopod 1 article 2 anterior margin more setose; palm of gnathopod 2 not as strongly excavate.

*Holotype*: ♂, USNM No. 152671.

*Paratypes*: 23 ♂ ♀, USNM No. 152672.

*Type-locality*: Oyster beds in Delaware Bay, 75°22′W longitude, 39°12′N latitude; recorded salinity range 18–25‰, temperature range 1–26°C, depth 8 m; substratum consists of hard, oyster shell reefs intercalated with muddy shells and mud (Maurer and Watling, 1973).

*Distribution*: This species has thus far been found only in Delaware Bay. It occurs on hard substrata, usually in association with the hydroid *Tubularia crocea.* When the hydroid is found on fouling plates, *Parametopella inquilinus, Parapleustes aestuarius* Watling and Maurer, and *Stenothoe minuta* Holmes are found in large numbers in the sediment trapped at the base of the colony. In the oyster community, Maurer and Watling (1973) incorrectly identified this species as *P. cypris.*

*Relationships*: This species differs from *P. stelleri* (see Gurjanova, 1951) by its lack of an anteriorly-directed process on antenna 1 peduncle segment 1. It differs from *P. ninis* (see Barnard, 1962) by the large excavation of the palm of gnathopod 2 and by the short coxal plate 3. *P. vulgaris* can also be distinguished from *P. cypris* (see Holmes, 1905; Bousfield, 1973) by the form of gnathopod 2, and also by the antenna 1 peduncle segment 1 being shorter than segments 2 and 3 combined, the very long peduncle segments 4 and 5 of antenna 2, and by coxal plate 4 not covering the distal end of coxal plate 2.

*Etymology*: The specific name, from the Latin noun inquilinus = sojourner, refers to its inquilinous life habit.

*Acknowledgments*: The author would like to thank Mr. Tom Dean who brought the specimens to his attention and Dr. Don Maurer whose grants provided the funding under which the specimens were collected.

## Literature Cited

Barnard, J. L. 1962. Benthic marine Amphipoda of southern California: families Amphilochidae, Leucothoidae, Stenothoidae, Argissidae, Hyalidae. Pacific Nat. 3:116–163.

———. 1969. The families and genera of marine gammaridean Amphipoda. U.S. Nat. Mus. Bull. 271:1–535.

Bousfield, E. L. 1973. Shallow-water gammaridean Amphipoda of New England. Cornell University Press, Ithaca. xiv + 312 pp.

Gurjanova, E. 1951. Bokoplavy morej SSSR i sporedel'nykh vod (Amphipoda-Gammaridea). Opred. po Faune SSSR, Akad. Nauk SSSR, 41:1–1029.

Holmes, S. J. 1905. The Amphipoda of southern New England. Bull. U.S. Bur. Fish. 24:459–529.

Maurer, D., and Les Watling. 1973. Studies on the oyster community in Delaware: the effects of the estuarine environment on the associated fauna. Int. Rev. Ges. Hydrobiol. 58:161–201.

QH
1
B4X
NH

No. 40, pp. 433–438 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# *SHIINOA ELAGATA*, A NEW SPECIES OF PARASITIC COPEPOD (CYCLOPOIDA) FROM *ELAGATUS* (CARANGIDAE)

By Roger F. Cressey
*Smithsonian Institution, Washington, D.C. 20560*

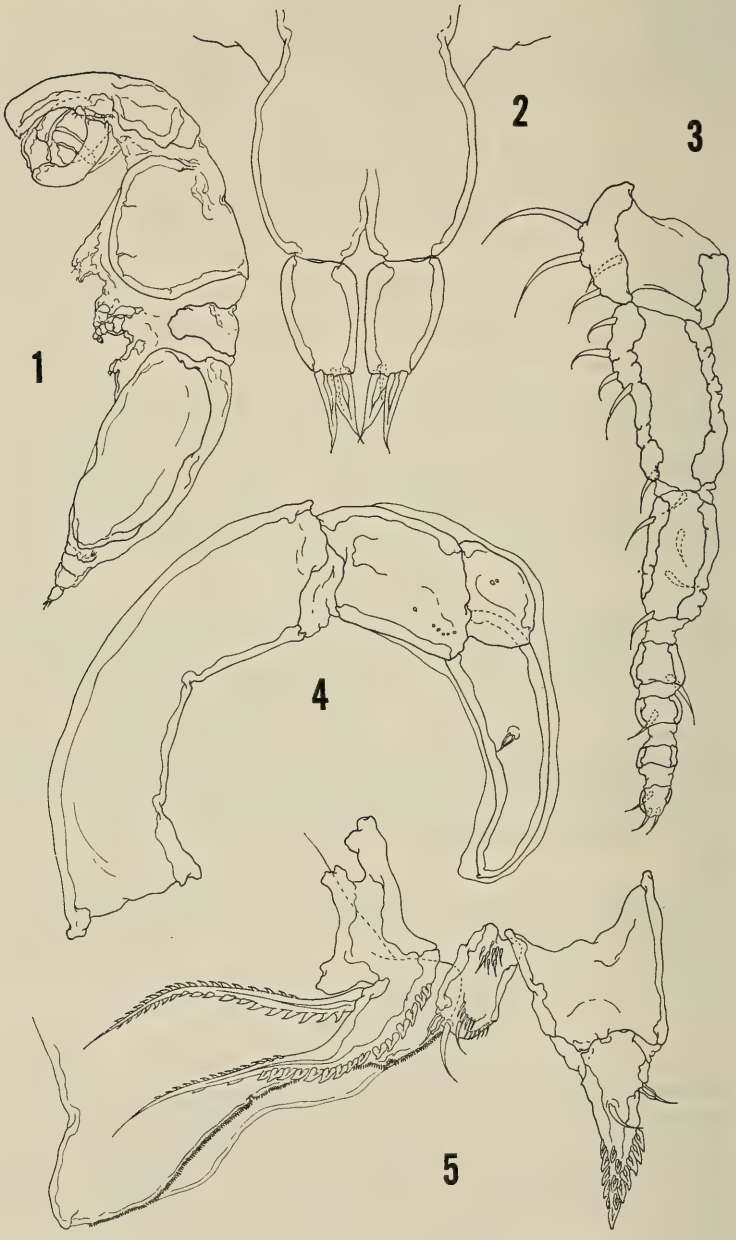
I recently described *Shiinoa inauris* Cressey and the male of *S. occlusa* Kabata from Atlantic and Pacific specimens of *Scomberomorus* respectively. Subsequent to the submission of that manuscript a third species was collected by Hillary Boyle from the nasal lamellae of the carangid *Elagatus bipinnulatus* (Quoy and Gaimard) from various Pacific localities. The hosts are in the collections of the California Academy of Sciences and I wish to thank Dr. William Eschmeyer for allowing Ms. Boyle to examine them for parasites. I examined a few specimens of Atlantic *Elagatus* in the Smithsonian collections but did not recover any further material. Examination of more Atlantic *Elagatus* might produce additional *Shiinoa*, as did the examination of Atlantic *Scomberomorus* cited above.

All drawings were made with the aid of a Wild Drawing Tube.

All material has been deposited in the collections of the Smithsonian Institution.

**Shiinoa elagata**, new species
Figures 1–12

*Material studied*: Holotype female (USNM 152651) from the nasal lamellae of *Elagatus bipinnulatus* and 4 paratype females (USNM 152652) from the same host collected from the Caroline Islands. One female from *Elagatus* sp. collected in the Gulf of Thailand (10°40′N, 99°32′E). Two females from *Elagatus* sp. from the same locality. One female from *Elagatus* sp. from Vanikoro Is. (11°41′S, 166°50′E). All additional material collected from the nasal lamellae of the host.


1
2
3
4
5

*Description*: Female.—Body form as in Fig. 1. Total length, 1.9 mm; greatest width, 1.25 mm, measured at widest part of genital segment. Body form more robust than *S. inauris* and *S. occlusa*. Rostral area produced anteriorly, curved ventrally, covering recurved second antennae as in other *Shiinoa* species. Cephalon posterior to second antennae constricted, followed by laterally expanded area bearing mouthparts and first legs. Cephalon comprising about ½ body length. Thoracic segments bearing second and third legs short, narrower than preceding and following segments with third leg appearing to be incorporated into genital segment ventrally.

Genital segment expanded laterally (see Fig. 10), somewhat longer than wide (1.3 × 1.2 mm). Abdomen (Fig. 2) segmentation obscured. Caudal rami (Fig. 5) longer than wide (171$\mu$ × 112$\mu$), bearing one lateral, one subterminal, and 4 terminal setae; all setae naked.

First antenna (Fig. 3) 7-segmented with short naked setae as indicated in figure, aesthaete present on last segment (seen in young forms only). Second antenna (Fig. 4) recurved within rostrum, terminal half with hyaline sheath, basal segment with 2 short, blunt setae along inner edge as indicated in figure, terminal segment with single short seta. Mouthparts (Figure 5) somewhat removed from first and second antennae and situated on ventral protuberance (see Fig. 1). Mandible terminating in long flagellum bearing stout pyriform spines along outer edge and smaller spinules along inner; inner seta arising near base of flagellum bearing spines on outer and inner edges. First maxilla, small, with 3 terminal setae and spinules as indicated in figure. Second maxilla terminating as stout heavily spinose process with 2 setae near base of spinose area. Maxilliped absent.

First leg (Fig. 6) with 3-segmented rami; exopod first and second segments with short spine on outer distal corner, last segment with 3 terminal spines and 3 short inner setae; endopod first segment with short seta on inner distal corner, second segment with prominent spinelike process on outer distal corner, last segment with 2 terminal prominent spinelike processes and 3 short inner setae; outer edges of both rami with spinules. Second leg (Fig. 7) as in first leg except exopod second segment with inner seta and small patch of spinules on basipod. Leg 3 (Fig. 8) uniramose, bearing 2 terminal spines, 1 seta, and patches of spinules as indicated in figure. Legs 4 and 5 absent. Leg 6 (Fig. 9) represented by sclerotized area bearing 1 short seta and 1 short spine at area of egg sac attachment.

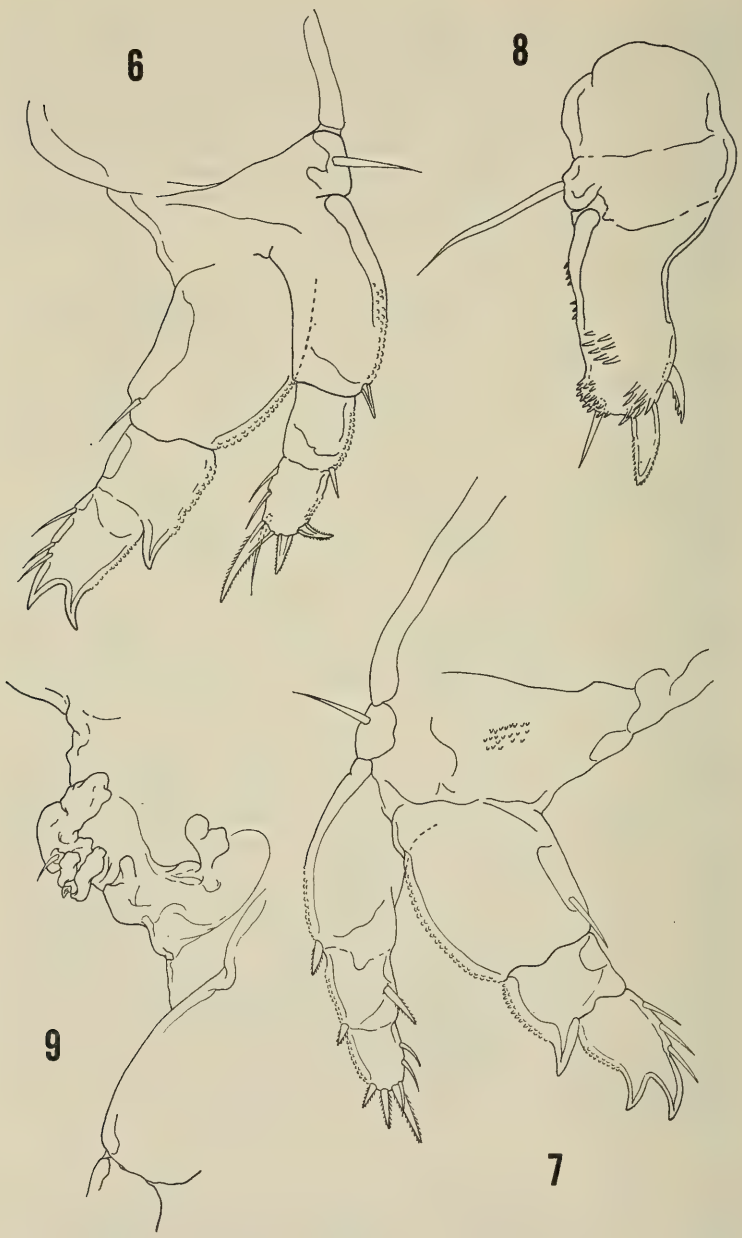
Egg sacs broken in ovigerous females but appear to be of the usual cyclopoid type with many eggs.

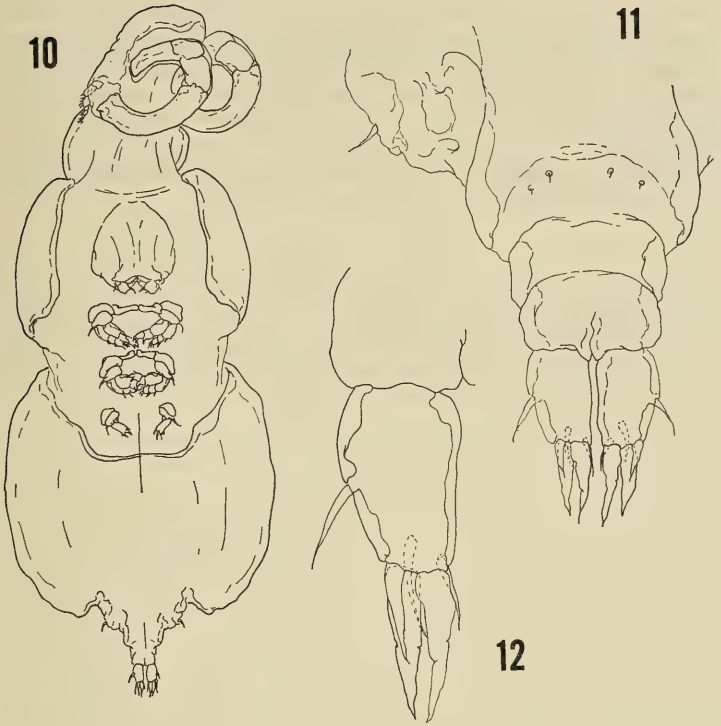
*Male*.—unknown.

---

←

Figs. 1–5. *Shiinoa elagata* n. sp., female: 1, Dorsal; 2, Abdomen and caudal rami; 3, First antenna; 4, Second antenna; 5, Mouthparts.


6
8
9
7




FIGS. 10–12. *Shiinoa elagata* n. sp., young female: 10, Ventral; 11, Abdomen, ventral; 12, Caudal ramus, ventral.

*Young female.*—a few specimens of smaller non-ovigerous females are present in the material examined and these forms exhibit a few differences from the mature females as follows; the ventral aspect (Fig. 10) was drawn from a young female but its general body form does not differ from the mature specimens. The abdomen (Fig. 11) segmentation is more distinct. The caudal rami (Fig. 12) each bear a lateral seta and 2 additional terminal setae. The first antenna bears more setae terminally (at least 7) and an aesthaete. The knobs present along the outer margins of the rami of legs 1 and 2 are pointed spinules in the younger forms.

---

←

FIGS. 6–9. *Shiinoa elagata* n. sp., female: 6, First leg; 7, Second leg; 8, Third leg; 9, Sixth leg and area of egg sac attachment.

*Remarks*: The new species can be easily separated from *S. inauris* since the rami of legs 1 and 2 of *inauris* are 2-segmented rather than 3. The new species seems more closely related to *S. occlusa* but can be separated from it by the nature of the body form, the greater number of setae on legs 1 and 2 of *S. elagata* and the patches of spinules on leg 3 of *elagata*.

*Etymology*: *elagata*. Latin, feminine, referring to the generic name of the host from which it was collected.

## Literature Cited

Cressey, R. F. 1975. A new family of parasitic copepods (Cyclopoida: Shiinoidae). Crustaceana 28(2):211–219.

Kabata, Z. 1968. Copepoda parasitic on Australian fishes VII. *Shiinoa occlusa* gen. et sp. nov. Jour. Nat. Hist. 2:497–504.

QH
1
B4X
NH

3, No. 41, pp. 439–446 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

SMITHSONIAN
1976

# *ORCONECTES SAXATILIS*, A NEW SPECIES OF CRAYFISH FROM EASTERN OKLAHOMA

By Raymond W. Bouchard and Judith W. Bouchard
*National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560*

A new species of crayfish from the Kiamichi River system (Red River basin) was discovered during a trip to western Arkansas and eastern Oklahoma. This new species brings to 10 the number of representatives of *Orconectes* in Oklahoma. *Orconectes leptogonopodus* Hobbs (1948:146), *O. menae* (Creaser 1933:5), *O. acares* Fitzpatrick (1965:87), *Procambarus* (*Tenuicambarus*) *tenuis* Hobbs (1950:194) and the species described herein all appear to be endemic to the Ouachita Mountains section.

We wish to thank Horton H. Hobbs, Jr., of the Smithsonian Institution who reviewed the manuscript. We also are indebted to the Smithsonian Institution for providing a Smithsonian Postdoctoral Fellowship to the senior author.

**Orconectes saxatilis**, new species
Figure 1*a–k*

*Diagnosis*: Body and eyes with pigment. Rostrum with marginal spines. Areola 6.0 to 9.3 times longer than broad, constituting 28.7 to 29.9 percent of total length of carapace (37.8 to 38.8 percent of postorbital carapace length) and with 3 punctations across narrowest part. No cervical spines or tubercles present. Hepatic spines absent; branchiostegal spine small and acute; suborbital angle weakly developed; postorbital ridges moderately well developed and terminating cephalically in acute, corneous-tipped spine. Antennal scale longer than broad, broadest slightly distal to midlength; lamellar portion with broadly angulate to slightly declivous margin. Chela with 2 subserrate rows of low tubercles along mesial margin of palm; scattered smaller tubercles over dorsomesial half of palm; small setal tufts over entire dorsal surface; moderately well developed longitudinal ridges on dorsal surface

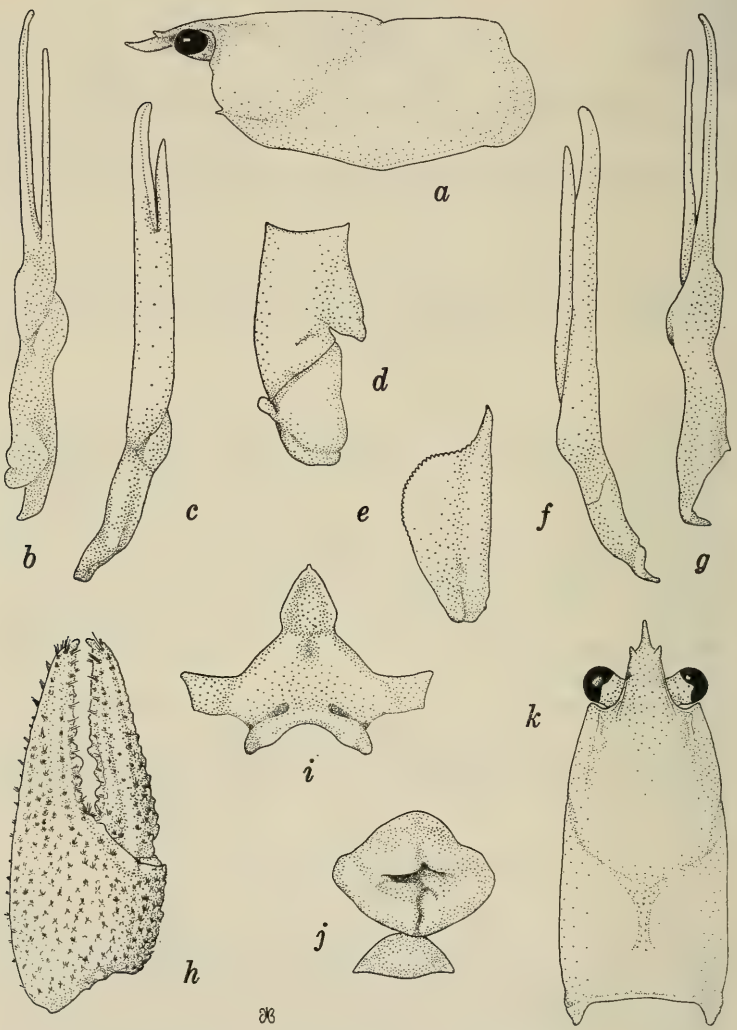



FIG. 1. *Orconectes saxatilis*, new species. *a*, Lateral view of carapace of holotype; *b*, Mesial view of first pleopod of holotype; *c*, Mesial view of first pleopod of morphotypic male; *d*, Basipodite and ischiopodite of third pereiopod of holotype; *e*, Antennal scale of morphotypic male; *f*, Lateral view of first pleopod of morphotypic male; *g*, Lateral view of first pleopod of holotype; *h*, Dorsal view of chela of holotype; *i*, Epistome of allotype; *j*, Annulus ventralis of allotype; *k*, Dorsal view of carapace of holotype.

of fingers. Hook on ischium of third pereiopod of first form male overreaching basioischial articulation. First pleopod of first form male with central projection corneous, tapering and reaching basis of first pair of pereiopods when abdomen flexed; shoulder present on cephalic surface; mesial process slightly shorter, non-corneous, with distal end curved mesiad. Annulus ventralis symmetrical; cephalic half divided by medial trough and bearing 2 caudally directed protuberances overhanging centrally located fossa; sinuate sinus extending from fossa to caudal edge of sclerite; tongue-like projection extending into fossa.

*Holotypic male, form I*: Body subovate and somewhat laterally compressed (Figs. 1*a, k*). Abdomen narrower than thorax (9.0 and 9.6 mm). Greatest width of carapace greater than depth at caudodorsal margin of cervical groove (9.6 and 8.9 mm). Areola 9.3 times longer than wide with 3 punctations across narrowest part; length of areola 29.3 percent of entire length of carapace (38.0 percent of postorbital carapace length). Rostrum with thickened, concave margins terminating in large, acute, corneous spines. Acumen terminating in small, upturned, corneous tubercle reaching nearly to end of antennular peduncle. Rostrum excavate dorsally with submarginal punctations and scattered additional ones. Postorbital ridge moderately developed, grooved dorsolaterally, terminating in prominent, acute, corneous tubercle. Suborbital angle poorly developed; branchiostegal spine large, acute and corneous. No cervical spines present; hepatic area tuberculate; dorsal surface and branchiostegal portions of carapace punctate.

Abdomen longer than carapace (24.3 and 22.2 mm); pleura of moderate length with caudoventral extremity subangular. Cephalic section of telson with single movable and immovable spine in each caudolateral corner; partly separated from caudal section by 2 oblique incisions. Basal podomere of uropod with spine extending over mesial and lateral rami. Lateral ramus of uropod with median and submedian ridges, former terminating in acute spine at transverse flexure. Proximal part of lateral ramus with row of small spines distally and large movable spine submarginally at caudolateral corner. Mesial ramus of right uropod with median ridge terminating distally in premarginal acute spine, left missing; lateral margin terminating distally in acute spine. Dorsal surface of telson and uropods lightly setiferous.

Cephalic lobe of epistome (Figure 1*i*) triangular and narrow with small cephalomedian projection and thickened, upturned cephalolateral margins. Main body of epistome with very shallow median fovea and pair of obliquely disposed oval fossae immediately cephalic and subparallel to thickened, arched epistomal zygoma. Proximal segment of antennule with small spine on ventral surface near base of proximal third. Antennae broken. Antennal scale (Figure 1*e*) with broadly angulate lamellar margin, broadest slightly distal to midlength; thickened lateral part terminating in prominent, acute, corneous-tipped spine projecting anteriorly beyond tip of rostrum.

Left chela (Fig. 1*h*) (right chela missing) with mesial margin of palm

bearing primary subserrate row of 9 tubercles and secondary row of 8 slightly smaller tubercles on dorsal surface lateral to primary row; scattered small tubercles over dorsomesial half of palm; distoventral surface of palm with 2 corneous-tipped spines. Lateral surface of propodus weakly costate with row of punctations rendering proximolateral base slightly impressed dorsally; dorsal and ventral surfaces with submedian ridges flanked by setiferous punctations; opposable surface with row of 6 tubercles along proximal three-fifths of finger, fourth from base largest; additional acute tubercle present on lower level near base of distal fourth; single row of minute denticles extending proximally from tip to third tubercle from base, interrupted by each of fourth through sixth tubercles. Dorsal and ventral surfaces of dactyl with median longitudinal ridges flanked by setiferous punctations; opposable margin with row of 8 tubercles, fourth from base largest; row of denticles extending proximally from tip to third tubercle from base, interrupted by fourth through seventh tubercles; mesial surface with irregular rows of tubercles on approximately basal half with single row of progressively smaller tubercles extending distally. Fingers terminating in large, acute, corneous spines.

Left carpus with deep oblique furrow dorsally; mesial surface with large, procurved, corneous-tipped spine near midlength and 8 smaller, scattered tubercles; distoventral margin with 2 large, corneous-tipped spines, medial one procurved; dorsal surface with small, acute, corneous-tipped spine distomesially and row of 4 small tubercles dorsomesially; podomere otherwise punctate.

Upper surface of left merus with 2 prominent corneous-tipped spines and 3 similar but much smaller ones at distal margin; ventral surface with lateral row of 5 cornified tubercles, distal 2 largest and mesial row of 11 similar tubercles; large corneous-tipped tubercle at lateral articulation. Left ischium with row of 3 small tubercles on ventromesial margin, first cornified, other 2 broken or abraded.

Hook on ischium of third pereiopod only (Figure 1*d*); hook simple, overreaching basioischial articulation and not opposed by tubercle on basis. Coxae of fourth and fifth pereiopods without prominent caudomesial boss. (See Measurements.)

First pleopod (Figs. 1*b*, *g*) reaching basis of first pereiopod when abdomen flexed. (See *Diagnosis* for description.)

*Allotypic female*: Similar to holotype in most respects but differing as follows: areola constituting 29.9 percent of entire length of carapace (38.8 percent postorbital carapace length), and width 7.2 times longer than broad. Postorbital ridges and rostrum with larger spines. Antennal scale with more declivous margin on lamellar portion. First chelipeds regenerated. Sternum between third and fourth pereiopods broadly U-shaped and shallow. Annulus ventralis (Figure 1*j*) firmly attached to sternum cephalically. See *Diagnosis* for description of annulus ventralis.

*Morphotypic male, form II*: Differing from holotype in following respects: rostrum and postorbital ridges terminating in larger spines.

Areola constituting 29.1 percent of entire length of carapace (38.5 percent of postorbital carapace length), and 7.8 times longer than broad. Mesial margin of palm of right chela (left regenerated) with primary subserrate row of 10 tubercles. Propodus of right chela with 7 tubercles along opposable margin; single row of denticles interrupted by tubercles 4 through 7. Opposable margin of dactyl with row of 7 tubercles, first and fourth from base largest. Carpus with 6 and 9 tubercles on mesial and dorsal surfaces respectively; 2 subequal, corneous-tipped spines and 3 rounded tubercles on ventral surface. Upper surface of merus with 3 corneous-tipped spines and 3 of 4 tubercles at distal margin cornified; ventromesial margin with 12 tubercles; ventrolateral margin with distal tubercle largest. Ischium of right cheliped with 4 acute, corneous-tipped tubercles. Hook on ischium of third pereiopod much reduced, not reaching basioischial articulation. First pleopods (Figs. 1*c*, *f*) long and of uniform texture, neither element corneous; central projection longer and curved at tip; mesial process straight.

*Type-locality*: Pigeon Creek at Oklahoma State Highway 63 (Red River basin via Kiamichi River system), LeFlore County, Oklahoma. The creek bottom is comprised of masses of cobbles and numerous rocks of various sizes. During the summer the flow is sluggish with visible water confined to isolated pools, the latter connected by subsurface flow. On 11 August 1974 the clear water was less than 2 feet deep with a temperature of 24°C. Pigeon Creek is approximately 15 feet wide with occasional concentrations of the emergent aquatic plant, *Justicia americana*.

*Disposition of types*: The holotypic male, form I (USNM 146577), the allotype (USNM 146578) and the morphotypic male, form II (USNM 146579) are deposited in the National Museum of Natural History, Smithsonian Institution. Paratypes consisting of 1 ♂ II, 2 ♀, 2 ♂ juv. and 2 ♀ juv. are deposited also in the Smithsonian Institution, and 1 ♂ I, 1 ♂ II and 2 ♀ are in the collection of the senior author.

*Range and specimens examined*: This crayfish is known only from the type-locality and the type-series as indicated above. Probably the species will prove to be more widespread in the upper Kiamichi River system.

*Variation*: Other than the usual range in meristics, morphometrics and setation, there is little variation in the available material. (See *Diagnosis*.) Abrasion of spines or tubercles in late intermolt stages are noticeable.

*Size*: The largest specimen available is a female with a carapace length of 26.1 mm (postorbital carapace length 20.2 mm). The smallest first form male has corresponding lengths of 22.0 and 17.0 mm.

*Color notes*: Cephalothorax and abdomen concolorous sienna. Branchiostegites and hepatic region lighter. Caudal edge of cephalothorax with prominent dark brown band. Caudal edges of abdominal terga with narrow, dark brown bands; pleura with red crescentic markings. Tail fan with narrow red margination. Pair of dark vermiculated blotches anterior to cervical groove marking attachment of mandibular muscles. Ventral aspects of cephalothorax and abdomen white.

TABLE 1. Measurements (mm) of *Orconectes saxatilis*

| | Holotype | Allotype | Morphotype |
|---|---|---|---|
| Carapace | | | |
| Height | 8.9 | 10.1 | 8.5 |
| Width | 9.6 | 12.1 | 9.5 |
| Total length | 22.2 | 26.1 | 21.3 |
| Postorbital length | 17.1 | 20.1 | 16.1 |
| Areola | | | |
| Width | 0.7 | 1.1 | 0.8 |
| Length | 6.5 | 7.9 | 6.2 |
| Rostrum | | | |
| Width | 2.6 | 2.9 | 2.4 |
| Length | 5.1 | 6.0 | 5.2 |
| Chela | | | |
| Length, mesial margin palm | 5.3 | —* | 5.2 |
| Width, palm | 7.5 | — | 6.3 |
| Length, lateral margin | 17.9 | — | 15.5 |
| Length, dactyl | 10.9 | — | 9.4 |

* Chelae regenerated

Chelae sienna dorsally, white ventrally. Distal ends of fingers red. Pereiopods lighter sienna dorsolaterally, cream to white ventrolaterally; distal podomeres darker dorsally than proximal ones.

Rostral margins dark brown; antennae sienna and tubercles on opposable margins of fingers yellow.

*Life history notes*: First form males have been collected only during the month of August. A large percentage of the adult male population is probably in reproductive form during late summer through early spring. No ovigerous females were collected but egg laying probably occurs during late winter to early spring.

*Ecological notes*: *Orconectes saxatilis* was collected under rocks in the pool areas. Taken with this new species at the type-locality were *Orconectes palmeri longimanus* (Faxon 1898) and *Procambarus* (*Tenuicambarus*) *tenuis* Hobbs (1950). *Orconectes palmeri* was the dominant crayfish at the type-locality. Unlike the usual habitat of the adults of its close ally, *O. menae*, which prefers the deeper, faster riffles and runs, the habitat of *O. saxatilis* had little current. The above mentioned associates are also more common in quieter waters.

*Relationships*: *Orconectes saxatilis* has its closest affinities with *Orconectes menae* (Creaser 1933) which is known from the Ouachita and Red River systems of the Ouachita province. It differs from *O. menae* primarily in possessing longer gonopods with a distinct cephalic shoulder

in the first form male (not reaching forward to the bases of the first pair of pereiopods in *O. menae*) and a more uniform color pattern (dark stippling or rosette patterns are obvious on *O. menae*). *Orconectes saxatilis* and *O. menae* share a unique combination of morphological characters such as a narrow, triangular cephalic lobe on the epistome; the absence of cervical spines; and lack of the caudally directed expansion of the annulus ventralis.

*Etymology*: *saxatilis*, L., found among rocks; so named because of the habitat at the type-locality which is dominated by numerous rocks.

## Literature Cited

Creaser, Edwin P. 1933. Descriptions of some new and poorly known species of North American crayfishes. Occ. Pap. Mus. Zool., Univ. Michigan 275:21 pp.

Faxon, Walter. 1898. Observations on the Astacidae in the United States National Museum and in the Museum of Comparative Zoology, with descriptions of new species. Proc. U.S. Nat. Mus. 20(1136):643–694.

Fitzpatrick, Joseph F., Jr. 1965. A new subspecies of the crawfish *Orconectes leptogonopodus* from the Ouachita River drainage in Arkansas. Tulane Stud. Zool. 12(3):87–91.

Hobbs, Horton H., Jr. 1948. Two new crayfishes of the genus *Orconectes* from Arkansas, with a key to the species of the Hylas Group (Decapoda, Astacidae). Amer. Midl. Natur. 39(1): 139–150.

———. 1950. A new crayfish of the genus *Procambarus* from Oklahoma and Arkansas (Decapoda, Astacidae). Jour. Washington Acad. Sci. 40(6):194–198.

QH
1
B4X
NH

88, No. 42, pp. 447–458 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES FEB 1976

# TWO NEW SPECIES OF OCTOPODS OF THE GENUS *GRANELEDONE* (MOLLUSCA: CEPHALOPODA) FROM THE SOUTHERN OCEAN[1]

By Gilbert L. Voss
*Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida 33149*

The cephalopod collections taken from Antarctic seas by the USNS Eltanin are rich in benthic octopods. These are being worked upon by the writer and the final results will form a monographic study of the octopods of the Southern Ocean. Because of the time involved in working up the collections and the complexities of the taxonomic problems, the descriptions of the new species are being published separately in a series of papers in order to make them immediately available to other students of the group.

The genus *Graneledone* is poorly known. Most of the species descriptions are inadequate for identification and comparisons, and, due to the poor state of preservation of most of the material, little is known concerning the internal anatomy of the component species. The present paper helps to remedy this situation and is preliminary to a more detailed and comprehensive study of the genus.

I wish to thank those responsible for the collection and preservation of the specimens, for their care in handling them, and for their excellent state of preservation. I also wish to thank Dr. George Llano, head of the Biology Program of the NSF Office of Antarctic Programs, for making this work possible. This research was supported by National Science Foun-

[1] Scientific Contribution from the Rosenstiel School of Marine and Atmospheric Science, University of Miami. This paper constitutes a scientific report to the National Science Foundation.

dation grants GA 0253, GA 1493 and BMS 70-00851 A04 for which I am grateful.

The illustrations of *Graneledone macrotyla* are by Constance Stolen McSweeny; the drawings of *G. antarctica* are by the writer; Roger Hanlon took the photographs. The measurements and indices used are those defined by Voss (1963:11). The types are deposited in the U.S. National Museum of Natural History.

**Graneledone antarctica**, new species

Figures 1a–i, 2

*Material studied*: Holotype—male, mantle length 41 mm, from Ross Sea, Eltanin Sta. 2110, 74°05.6′S, 175°05.2′W in 2341 m with 10-foot Blake trawl, February 8, 1968, USNM 729679. Paratypes—male, mantle length 39 mm, female, mantle length 45 mm, UMML 1667. Male, mantle length 38 mm, 3 females, mantle length 25–41 mm, USNM 729680. (All paratypes with same data as holotype.)

*Description*: The mantle is short, broadly rounded posteriorly, and very wide. It is distinctly flattened dorso-ventrally. The head is set off from the mantle by a slight constriction. The head is nearly as wide as the mantle, flattened, and bears large conspicuous eyes.

The funnel is of moderate size; it is free for its anterior half which is tubular and tapered. The funnel organ is VV-shaped but shows considerable variation (Figs. 1a, b). It is composed of 2 elongate oval pads slightly to moderately split anteriorly with pointed to blunt tips.

The arms are long and rather stout; the arm order is 1.2.3.4, either I or II always being the longest and IV always the shortest. The web is moderately deep with the formula C = B.D.A = E but showing some individual variation. The web extends only a short distance up the dorsal side of each arm after which there is no trace. On the ventral side of I, II, and III the web extends to the tip of the arm. It is low in the basal half but at about the midpoint of the arm it broadens, becoming widest at about the distal ⅕ of the arm. Only the extreme tip of the arm is free. On preservation, the contraction of the web curls the arm tip in a pronounced fashion. The arm web attains its greatest development on I and II. The suckers are small and in a single row on each arm. They are largest near the base of the arm and regularly decrease in size toward the arm tip.

The third right arm is hectocotylized in the male. It is bordered ventrally by a membrane or web, its outer margin thickened, cream-colored, and rolled outward. The contraction of this thickened border curls the arm tip downward resembling a hook or a slight S-curve. This shape is probably not found in the living animal but is due to the action of the preservative. The tip of the arm bears a small ligula (Fig. 1c). It is spoon-shaped, pointed distally, and has thickened margins. The

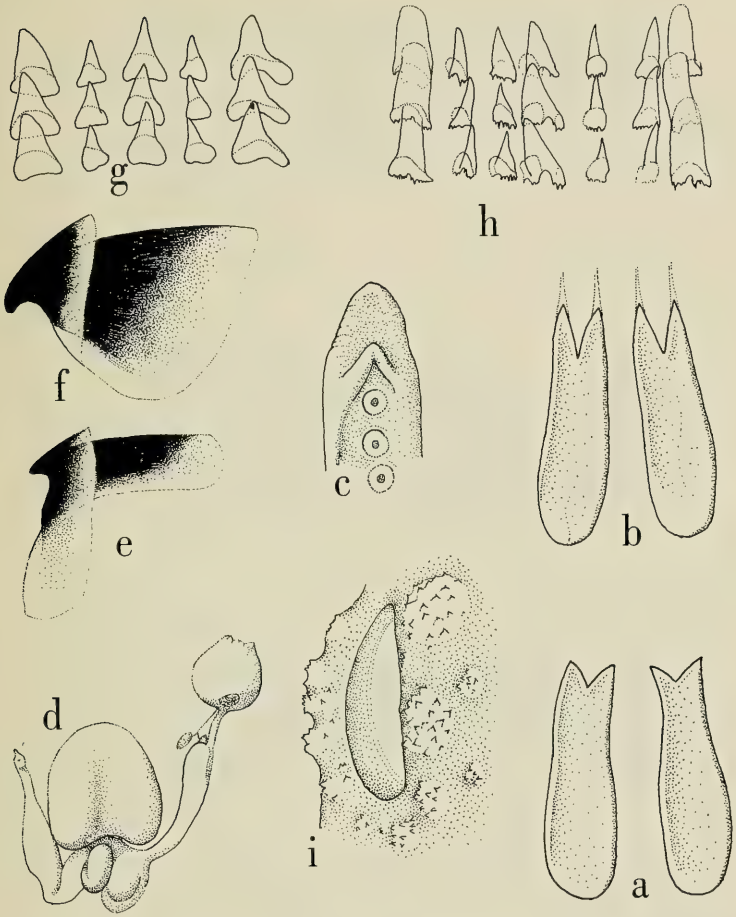



FIG. 1. *Graneledone antarctica*, new species. a–b, Funnel organs; c, Hectocotylus of holotype; d, Digestive tract of female; e–f, Mandibles; g, Radula of 39 mm specimen; h, Radula of 38 mm specimen.

oral face is crossed by about 12–13 low fleshy folds. The calamus is projecting, low, and blunt.

The gills are short, stout, and contain 6 lamellae on the outer demibranch.

None of the specimens appear to be sexually mature. The holotype had a well developed hectocotylus and penial apparatus but there were no spermatophores in Needham's sac nor were any found in the other males.

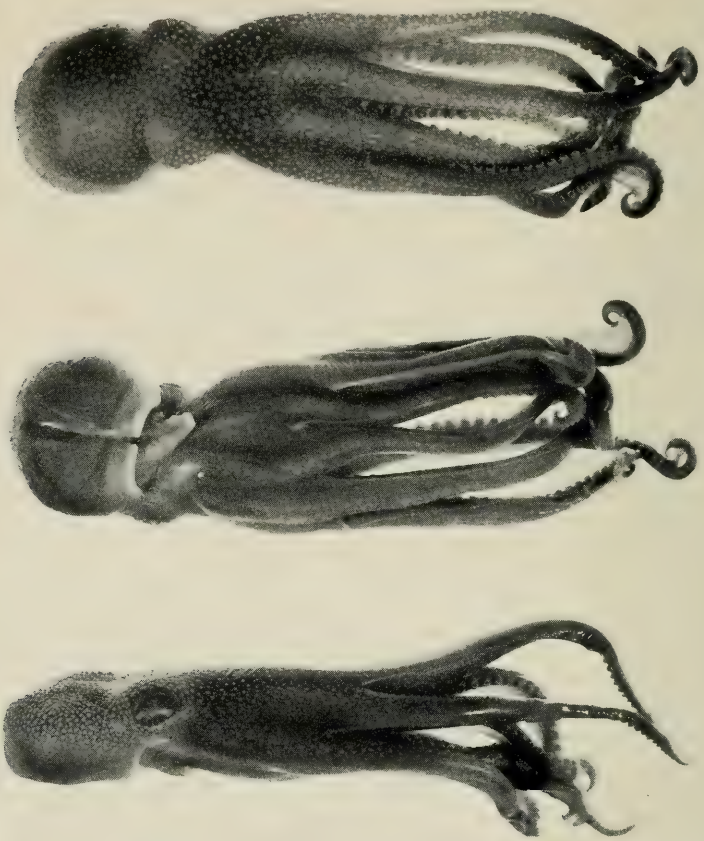


Fig. 2. *Graneledone antarctica*, new species. Upper figures of holotype; lower figure of 38 mm paratype.

None of the females contained developed eggs.

The digestive tract was dissected from one of the large females (Fig. 1d). The buccal mass is large and contains large anterior salivary glands. The paired posterior salivary glands are very small and poorly developed. The esophagus leads from the buccal mass posteriorly to the crop which it enters dorsally. The latter has no diverticulum. Posteriorly the esophagus and crop lead into a stout portion which connects with a moderately large two-parted stomach, one part thick-walled and muscular, the other thin-walled. The spiral caecum is small, stout, smooth externally, and united with the small heart-shaped liver by paired hepatopancreatic ducts. The intestine is stout, thin-walled, and leads anteriorly to the anus which does not appear to have anal flaps. The crop was opened

in one specimen. It contained an amorphous mass of animal tissue in which numerous polychaete bristles were embedded.

The beaks show no unusual features (Figs. 1e, f).

Radulas were removed from two specimens. While there is no question that all of the specimens are conspecific and show a remarkably close conformity in other characters, the radular teeth vary greatly. The radula from specimen No. 2 (Fig. 1g) has only 5 teeth in each transverse row, none of them showing any great dissimilarity. The rachidians are undifferentiated but somewhat larger than the second laterals and without cusps. The admedians or first laterals are missing. The second laterals are only slightly curved with small bases; the third laterals are largest, tallest, and broadest, with conspicuous bases. There is no trace of marginal plates.

The radula of specimen No. 3 (Fig. 1h) has rather large, broad rachidians with broad bases, perhaps somewhat distorted in the figure by a sidewise orientation in the mount. The admedians are a little shorter than the second laterals, narrow and sharp. The second laterals are larger and more curved. The third laterals are very broad, almost flattened at their tips and show a slightly irregular outline. All of these teeth stand erect, are thin and transparent, and in No. 3 have very irregular almost root-like bases.

All of the specimens were fixed in 10 percent buffered formalin after brief emersion in fresh water to kill them. They were thus fixed without undue distortion of the arms and were later transferred to 70 percent alcohol. They are in remarkably fine condition for examination.

The general consistency is muscular with a thick overlying layer of almost gelatinous material, particularly posteriorly on the mantle and slightly less so dorsally, around the head and eyes, and surrounding the brachial crown. The surface is covered by a thin, very tough skin which is covered dorsally on the mantle, head and arms by numerous, evenly spaced, close-set warts (Fig. 2). These consist of a raised mound bearing from one to over a dozen small, cone-shaped papillae. They are very regularly distributed. There are none on arms IV; arms II and III are liberally covered dorsally but there are none ventrally. There is a distinct line of fine warts on the periphery of the mantle arranged like a keel running from the corners of the mantle aperture around the mantle posteriorly. Below the keel there are no warts and the surface is smooth. There are no warts beneath the head except for a few bordering the lower eyelid and immediately adjacent to it. There is a distinct circlet of warts on the eyelid (Fig. 1i). These are somewhat larger than the other warts and two or three of them over each eye are greatly enlarged and, although not erected, probably represent ocular cirri.

The color of specimens in alcohol is a pale yellowish brown dorsally, suffused with purplish hues at the base of the brachial crown and on and between the arm bases. On this ground color the mantle, head, funnel, and the base of the arms are reddish brown suffused with purple. The spermatophoral groove on the third right arm is yellowish.

TABLE 1. Measurements (in mm) of 3 male specimens of *Graneledone antarctica*, new species, from ELTANIN Sta. 2110.

| | Holotype | | |
|---|---|---|---|
| No. | 1 | 2 | 3 |
| Mantle length | 41 | 39 | 38 |
| Mantle width | 44 | 37 | 40 |
| Head width | 40 | 34 | 38 |
| Arm length I | 164 165 | 138 138 | 138 136 |
| II | 164 164 | 123 130 | 127 136 |
| III | 150 145 | 112 105 | 119 117 |
| IV | 135 135 | 103 98 | 113 105 |
| Total length | 208 | 179 | 178 |
| Arm width | 8.0 | 7.0 | 7.0 |
| Hect. arm length | 145 | 105 | 117 |
| Ligula length | 4.5 | 4.0 | 3.8 |
| Calamus length | 2.0 | 2.0 | 1.5 |
| Sucker diameter | 3.3 | 2.3 | 2.2 |
| Web depth A | 28 | 30 | 25 |
| B | 46 47 | 35 38 | 33 42 |
| C | 45 52 | 35 35 | 38 38 |
| D | 33 | 27 | 30 |
| Gills | 6 | 6 | 6 |

TABLE 2. Indices of bodily proportions of three males of *Graneledone antarctica*, new species, from ELTANIN Sta. 2110.

| No. | 1 | 2 | 3 | N | Range | S.D. |
|---|---|---|---|---|---|---|
| ML | 41 | 39 | 38 | 3 | 38.0 – *39.3* – 41 | 1.52 |
| MWI | 107.3 | 94.9 | 105.3 | | 94.9 – *102.5* – 107.3 | 6.65 |
| HWI | 97.6 | 87.2 | 100.0 | | 87.2 – *94.9* – 100.0 | 6.80 |
| MAI | 24.9 | 28.3 | 27.5 | | 24.9 – *26.9* – 28.3 | 1.77 |
| ALI | 79.3 | 77.0 | 77.5 | | 77.0 – *77.9* – 79.3 | 1.20 |
| AWI | 19.5 | 18.0 | 18.4 | | 18.0 – *18.6* – 19.5 | 0.77 |
| WDI | 31.5 | 27.5 | 30.4 | | 27.5 – *29.8* – 31.5 | 2.06 |
| SIn | 8.0 | 5.9 | 5.8 | | 5.8 – *6.6* – 8.0 | 1.24 |
| HcAI | 87.8 | 76.1 | 84.8 | | 76.1 – *82.9* – 87.8 | 6.07 |
| LLI | 3.1 | 2.8 | 3.2 | | 2.8 – *3.0* – 3.2 | 0.20 |
| CLI | 44.4 | 50.0 | 39.5 | | 39.5 – *44.6* – 50.0 | 5.25 |
| PLI | | | | | | |
| Arm formula | 1.2.3.4 | 1.2.3.4 | 1.2.3.4 | | | |
| Web formula | CBDEA | BCDAE | CBDEA | | | |
| Gills | 6 | 6 | 6 | | | |

TABLE 3. Measurements (in mm) of four females of *Graneledone antarctica*, new species, from ELTANIN Sta. 2110.

| No. | 4 | 5 | 6 | 7 |
|---|---|---|---|---|
| Mantle length | 45.0 | 41 | 39 | 25 |
| Mantle width | 43 | 37 | 36 | 23 |
| Head width | 40 | 32 | 34 | 23 |
| Arm length I | 131 134 | 99 102 | 116 115 | 60 62 |
| II | 134 134 | 98 99 | 108 114 | 62 61 |
| III | 122 118 | 97 93 | 96 102 | 58 60 |
| IV | 198+ 114 | 86 57+ | 96 101 | 59 56 |
| Total length | 177 | 143 | 157 | 88 |
| Arm width | 8.0 | 5.5 | 6.0 | 6.0 |
| Web depth A | 32 | 25 | 28 | 17 |
| B | 41 42 | 30 32 | 32 37 | 18 — |
| C | 42 43 | 35 33 | 32 37 | 21 20 |
| D | 37 38 | 32 32 | 32 31 | 19 17 |
| E | 31 | 20 | 22 | 17 |
| Gills | 6 | 6 | 6 | 6 |

+ = tip broken

*Holotype*: U.S. National Museum of Natural History 729679.

*Type-locality*: Ross Sea, Antarctica, ELTANIN Sta. 2110, 74°05.6′S, 175°05.2′W in 2341 m.

*Discussion*: Two other species assigned to *Graneledone* must be considered: *G. challengeri* (Berry, 1916) and ? *G. setebos* Robson, 1932.

*G. antarctica* superficially resembles *G. challengeri* in its bodily proportions. It differs from it in the structure of the funnel organ, hectocotylus, radula, and sculpture. The funnel organ in *antarctica* is formed of double oval pads slightly to moderately spilt anteriorly; in *challengeri* these organs are typically VV-shaped with narrow, pointed, anterior

TABLE 4. Indices of bodily proportions and counts of four females of *Graneledone antarctica*, new species from ELTANIN Sta. 2110.

| No. | 4 | 5 | 6 | 8 | Range | S.D. |
|---|---|---|---|---|---|---|
| ML | 45 | 41 | 39 | 25 | 25 – *37.5* – 45 | 8.69 |
| MWI | 95.6 | 90.2 | 92.3 | 92.0 | 90.2 – *92.5* – 95.6 | 2.25 |
| HWI | 88.9 | 78.1 | 87.1 | 92.0 | 78.1 – *80.5* – 92.0 | 5.97 |
| MAI | 33.6 | 40.2 | 33.6 | 40.3 | 33.6 – *36.9* – 40.3 | 3.83 |
| ALI | 75.7 | 71.3 | 73.9 | 70.5 | 70.5 – *72.8* – 75.7 | 2.39 |
| AWI | 17.8 | 13.4 | 15.3 | 24.0 | 13.4 – *17.6* – 24.0 | 4.61 |
| WDI | 32.1 | 34.3 | 31.9 | 33.9 | 31.9 – *33.1* – 34.3 | 1.22 |

limbs. In *antarctica* the ligula is small and moderately well differentiated; in *challengeri* the ligula is well formed, deeply excavated, with sharply differentiated calamus. The radula of *antarctica* is highly variable but shows a general uniformity of teeth; in *challengeri* the radula is more typically octopodan. The sculpture of *antarctica* varies from *challengeri* in the more scattered, more widely separated tubercles, and the presence of 2 to 3 much larger tubercles over the eyes. The wide membrane on the ventral side of the arms in *antarctica* also seems distinctive.

There is no point of comparison with ? *G. setebos* for the reasons given in the general discussion.

The etymology of the name is self-evident.

**Graneledone macrotyla**, new species

Figures 3a–g

*Material studied*: Holotype, a female, mantle length 34.5 mm, Eltanin Sta. 1592, 54°43′S, 55°30′W in 1647–2044 m with 10-foot Blake trawl, March 14, 1966. USNM 729678.

*Description*: Only a single specimen of this species was found in the collections. It is, however, so different from any known species of *Graneledone* that I do not hesitate to describe it as new.

The mantle wall is thick and muscular with some semigelatinous material forming an outer layer. The mantle is large, round, but somewhat dorsoventrally flattened, and is very wide. There is no noticeable constriction between the mantle and the head (Fig. 3a, b).

The mantle aperture is small and the funnel-mantle locking apparatus is weakly developed. The funnel is stout and tubular but it is united to the ventral surface of the head for most of its length. The funnel is VV-shaped and stout with broad lateral limbs slightly stouter than the median limbs (Fig. 3c).

The head is broad with medium sized eyes which do not project. There is a slight constriction between the head and the bases of the arms.

The brachial crown is well developed. The arms are moderately long, stout, and taper gradually to slender points. The arm formula is 2.3.1.4. The suckers are small and crowded together but arranged regularly in a single row.

The web is moderately deep. The web formula is C.D.B = A.E. The web extends as a broad membrane up the ventral side of each arm nearly to the tip.

The mantle had been opened in search of mesozoan parasites and some of the internal organs were damaged. The gills are small, about equally developed in each demibranch, with 7 lamellae, including the terminal ones, on the outer demibranch.

The digestive tract was dissected (Fig. 3d). The beaks offer no particular differences but are well developed (Fig. 3e). The radula consists of a rachidian with asymmetrically arranged cusps as shown in the

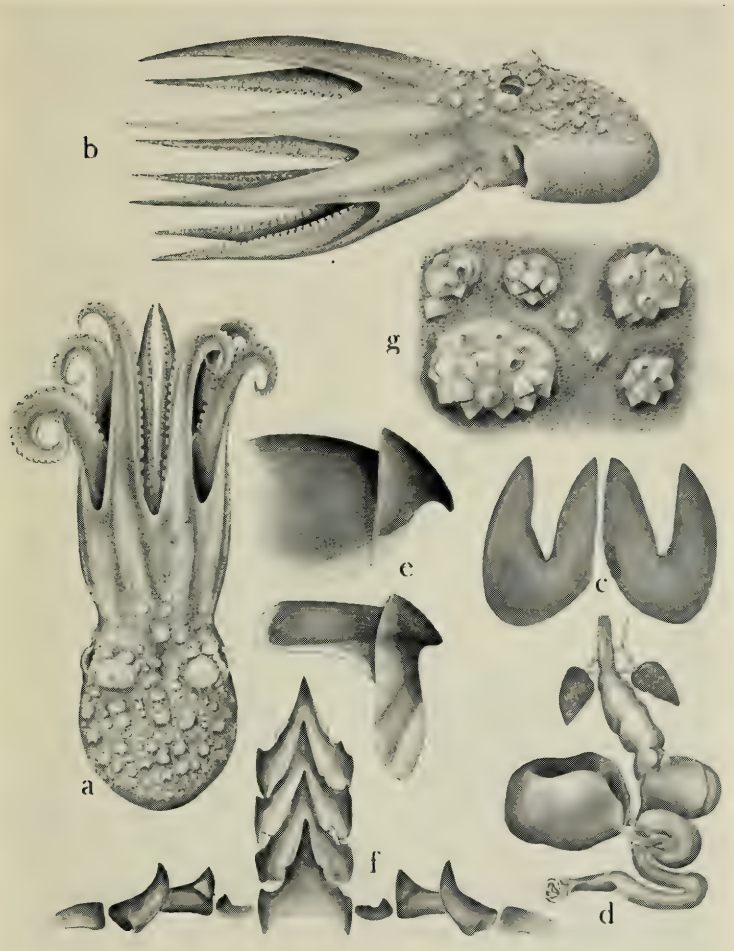



Fig. 3. *Graneledone macrotyla*, new species. Holotype: a–b, Dorsal and ventral views; c, Funnel organ; d, Digestive tract; e, Mandibles; f, Radula; g, Details of tuberculations.

figure (Fig. 3f). The admedian is small and somewhat bicuspid with the outer cusp more pronounced. The second lateral has a broad inner cusp with a short base. The third lateral is short, stout, and broad. The marginal plates are roughly triangular and rugose, the ridges or plications extending longitudinally of the plate.

TABLE 5. Measurements (in mm) and indices of the female holotype of *Graneledone microtyla*, new species.

| | | | |
|---|---|---|---|
| Mantle length | 34.5 | | |
| Mantle width | 38.0 | MWI | 110.0 |
| Head width | 36.0 | HWI | 104.0 |
| Arm length I | 81.0 | ALI | 70.0 |
| II | 87.0 | MAI | 39.7 |
| III | 83.0 | | |
| IV | 80.0 | | |
| Sucker diameter | 2.5 | $S1_n$ | 7.2 |
| Arm width | 7.5 | AWI | 21.7 |
| Length of gills | 8.0 | | |
| Gills | 7 | | |
| Total length | 124.0 | | |
| Web depth A | 24.0 | WDI | 32.2 |
| B | 24.0 | | |
| C | 28.0 | | |
| D | 25.5 | | |
| E | 20.0 | | |
| Arm formula | 2.3.1.4 | | |
| Web formula | CDB = AE | | |

The anterior salivary glands are small; the posterior salivary glands are triangular and small. The esophagus is stout and along much of its length is slightly dilated forming an indistinct crop of the type shown by Robson (1932, Fig. 30b) for *Bathypolypus* and which in fact is not a crop. This dilated portion of the esophagus leads into a strongly differentiated two-parted stomach and a distinct large, spiral caecum. The intestine is large, slightly dilated, and bent almost double upon itself. The anal pore is round, without the usual anterior and posterior folds or lateral flaps. There is no trace of an ink sac.

The crop and stomach were opened but contained little food remains. None was identifiable.

The genitalia unfortunately were removed at the time of capture while searching for mesozoans.

The sculpture is distinctive (Fig. 3a, b, g). There is a low, thin, peripheral keel or raised line around the mantle. Above the keel the surface is covered with well separated, distinct rugosities consisting of simple, sharp, cartilaginous tubercles, slightly larger groups of simple tubercles, and large areas 3–7 mm in diameter consisting of a pale raised area with small, simple tubercles surrounding an erect, central, sharp spine. There is a row of tuberculous papillae around each eye and a gigantic tuberculate cirrus about 10 mm in diameter above each eye. A color photograph of the living animal taken aboard the ship shows the two cirri erected to a height of about 15 mm. The tuberculations extend

onto the web and bases of the arms nearly to the level of the web margin. There are no tubercles on arms III and IV nor on the ventral surface of the head and mantle.

The color is a brownish red with deeper purple in the area of the brachial crown. The raised pale areas are creamy brown.

*Holotype*: U.S. National Museum of Natural History 729678.

*Type-locality*: Near the Falkland Islands, Eltanin Sta. 1592, 54°43'S, 55°30'W in 1647–2044 m.

*Discussion*: *G. macrotyla* resembles no other member of the genus in its superficial appearance. The few tubercles varying in size from minute to extraordinarily large ones, with a single enormous tubercle over each eye, immediately separates this species from all others in the genus. The radula is even more octopodan in general shape than that of *G. challengeri* which it most closely resembles in this feature.

The name *macrotyla* is derived from the Greek meaning large knobs and refers to the large tuberculations characteristic of the species.

## General Discussion

The genus *Graneledone* Joubin, 1918 may be diagnosed as follows: suckers uniserial; ink sac absent; funnel organ VV-shaped; crop reduced or absent; gills small; hectocotylus small; mantle and arms covered with small to large cartilaginous spiny warts. Robson (1932), listed four taxa: *G. verrucosa* (Verrill, 1881), *G. verrucosa media* (Joubin, 1918), *G. challengeri* (Berry, 1916), and ? *G. setebos* Robson, 1932.

*G. verrucosa*, and its possible subspecies *media*, is a North Atlantic species about which surprisingly little is known. From the literature, however, it differs considerably from the new species under consideration. At present, I am inclined to believe that the two forms do not warrant separation and represent a northern hemisphere species.

*G. challengeri*, of which the type is from off the Kermadec Islands, is confused because Robson (1932:311) included in his description Hoyle's (1904:21) *Moschites verrucosa* from the Gulf of Panamá. This latter specimen needs reexamination, including study of other now available specimens from the same region.

? *G. setebos* was first described by Massy as *Moschites* sp. (Massy, 1916:159). Robson (1932:313) placed the species in *Graneledone* without giving a single character to support his decision. None of the characters given either by Massy or Robson indicates that the specimen was a *Graneledone*. The specimen was taken dead in a rock pool and was badly decomposed so that no observations were possible concerning skin and sculpture, color, funnel, funnel organ, ink sac, etc. In my opinion *G. setebos* is a *species dubia* and should be dropped from further consideration.

## Literature Cited

Berry, S. Stillman. 1916. Cephalopoda of the Kermadec Islands. Proc. Acad. Nat. Sci., Philadelphia 68:45–66, 4 pls.

Hoyle, W. E. 1904. Reports on the Cephalopods, *in* Reports on the scientific results of the expedition to the eastern tropical Pacific . . . Albatross. Bull. Mus. Comp. Zool. 43(1):1–71, 10 pls.

Joubin, L. 1918 Céphalopodes recueillis au cours des croisières de S.A.S. le Prince de Monaco, 5e Note: *Moschites verrucosa* (Verrill). Bull. Inst. Oceanogr. Monaco No. 339:1–9.

Massy, A. L. 1916. Mollusca. Part II Cephalopoda. Brit. Antarct. ("Terra Nova") Exped. 1910. Zool. 2(7):141–175.

Robson, G. C. 1932. A monograph of the recent Cephalopoda. Vol. 2. Part II. The Octopoda (Excluding the Octopodinae). Brit. Mus. (Nat. Hist.), London, 359 pp., 6 pls.

Verrill, A. E. 1881. No. 5. Reports on the results of dredging . . . . "Blake" . . .X. Report on the cephalopods, and on some additional species dredged by the U.S. Fish Commission steamer "Fish Hawk," during the season of 1880. Bull. Mus. Comp. Zool. 8(5):99–116, 8 pls.

Voss, Gilbert L. 1963. Cephalopods of the Philippine Islands. U.S. Nat. Mus. Bull. 234:1–180, 4 pls.

QH
1
B4X
NH

3, No. 43, pp. 459–468 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# *ORCONECTES ETNIERI*, A NEW SPECIES OF CRAYFISH FROM WESTERN TENNESSEE AND NORTHERN MISSISSIPPI WITH NOTES ON *PROCAMBARUS ABLUSUS* AND *ORCONECTES WRIGHTI*

By Raymond W. Bouchard and Judith W. Bouchard
*National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560*

This new species of crayfish is known from the Mississippi Embayment province of Tennessee in the Tennessee, Forked Deer, Hatchie and Loosahatchie River systems where it is one of the more common species. In many western Tennessee collections from fluvial environments, it was the only species represented. Two of its associates, *Procambarus* (*Pennides*) *ablusus* Penn (1963:121) and *Orconectes wrighti* Hobbs (1948: 85), are known from only a few specimens. *Procambarus ablusus* was described on the basis of 7 specimens (4 adults) from 5 localities in Mississippi and Tennessee. Until recently, *O. wrighti* was known from only 11 specimens collected at the type-locality. Large populations of *P. ablusus* are more common in the Forked Deer River system, while *O. wrighti* occurs in an additional larger downstream tributary (see below) of the Tennessee River.

**Orconectes etnieri**, new species
Figure 1*a–k*

*Orconectes immunis*.—Penn, 1963:125.

*Diagnosis*: Body and eyes with pigment. Rostrum without marginal tubercles (may be present on juveniles). Areola 4.2 to 7.2 times longer than broad, constituting 26.3 to 30.3 percent of total length of carapace (35.4 to 39.4 percent of postorbital carapace length) with 2 to 4 punctations across narrowest part. Single cervical spine present on each side of carapace. Hepatic spines absent; branchiostegal spine small and

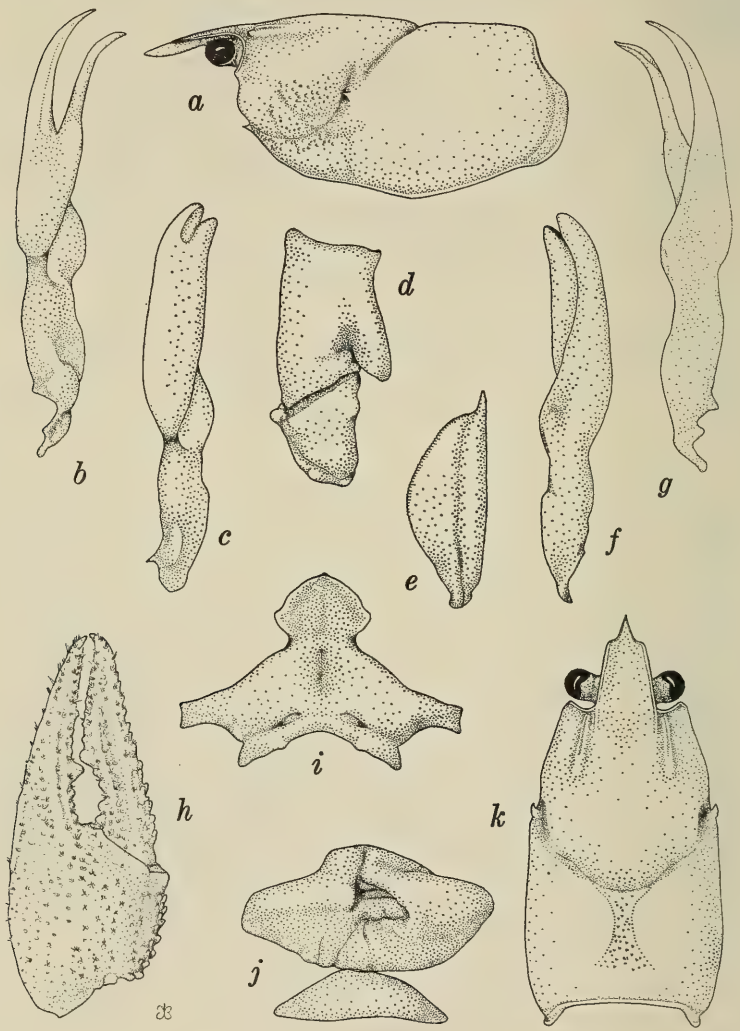



FIG. 1. *Orconectes etnieri*, new species. *a*, Lateral view of carapace of holotype; *b*, Mesial view of first pleopod of holotype; *c*, Mesial view of first pleopod of morphotypic male; *d*, Basipodite and ischiopodite of third pereiopod of holotype; *e*, Antennal scale of paratopotypic male, form I; *f*, Lateral view of first pleopod of morphotypic male; *g*, Lateral view of first pleopod of holotype; *h*, Dorsal view of chela of holotype; *i*, Epistome of holotype; *j*, Annulus ventralis of allotype; *k*, Dorsal view of carapace of holotype.

acute. Suborbital angle poorly developed, terminating cephalically in acute, corneous-tipped spine. Antennal scale longer than broad, broadest slightly distal to midlength; lamellar portion with 3 sided margin. Chela with two subserrate rows of tubercles along mesial margin of palm; scattered smaller tubercles over dorsomesial half of palm; small setal tufts over entire dorsal surface; lateral base of fixed finger impressed; well defined longitudinal ridges on dorsal surfaces of fingers. Hook on ischium of third pereiopod of first form male overreaching basioischial articulation. First pleopod of first form male with central projection corneous, tapering and reaching basis of second pair of pereiopods when abdomen flexed; mesial process shorter, non-corneous with distal end flared into shallow trough; distal ends of both elements curved caudally at same angle to shaft of appendage (see Fig. 1*b*, *g*).

*Holotypic male, form I*: Body subovate, somewhat depressed (Fig. 1*a*, *k*). Abdomen narrower than thorax (14.0 and 17.0 mm). Greatest width of carapace greater than depth at caudodorsal margin of cervical groove (17.0 and 14.0 mm). Areola 6.0 times longer than broad with 3 punctations across narrowest part; length of areola 28.8 percent of entire length of carapace (37.8 percent of postorbital carapace length). Rostrum with thickened, straight, subparallel margins devoid of marginal spines or tubercles. Acumen with concave, slender, margins, terminating in very small upturned, corneous tubercle, latter reaching end of antennular peduncle. Rostrum comparatively flat dorsally with slight impression basally; low, broad carina evident along flattened portion. Rostrum with submarginal punctations dorsally, others scattered between. Postorbital ridge moderately developed, shallowly grooved dorsolaterally and terminating cephalically in acute, corneous tubercle. Suborbital angle poorly developed and obtuse; branchiostegal spine small and acute. Single acute cervical spine on each side of carapace. Hepatic area and lateral portion of branchiostegite tuberculate; dorsal surface of carapace punctate.

Abdomen longer than carapace (35.2 and 31.3 mm); pleura of moderate length with caudoventral extremities subangular. Cephalic section of telson with marginal immovable spine and submarginal movable one in each caudolateral corner; partially separated from caudal section by 2 oblique incisions. Basal podomere of uropod with spine extending over lateral and mesial rami. Lateral ramus of uropod with median and submesial ridges, former terminating in acute spine at transverse flexure. Proximal portion of lateral ramus with row of spines distally and large movable spine submarginally at caudolateral corner (broken on right side). Mesial ramus of uropod with median ridge terminating distally in acute premarginal spine (missing on right side). Dorsal surface of telson and uropods lightly setiferous.

Cephalic lobe of epistome (Fig. 1*i*) spatulate with thickened, irregular cephalolateral margins, and lacking cephalomedian projection. Main body of epistome with very shallow median fovea and pair of obliquely disposed slitlike fossae immediately cephalic and subparallel to thickened,

arched epistomal zygoma. Proximal segment of antennule with small spine on ventral surface near midlength. Antennae broken. Antennal scale (Fig. 1*e*) broadest at at midlength with 3 sided margin on lamellar portion; thickened lateral portion terminating in prominent, acute, corneous-tipped spine reaching distal end of antennular peduncle.

Left chela (Fig. 1*h*) with mesial margin of palm possessing primary subserrate row of 8 tubercles and secondary row of 6 smaller ones on dorsal surface lateral to primary row; scattered tubercles over dorsomesial half of palm; distoventral surface of palm with 2 tubercles at base of dactyl; dorsal surface covered with numerous small setal tufts. Lateral surface of propodus costate with row of punctations rendering proximolateral base of finger impressed dorsally and less so ventrally; dorsal and ventral surfaces with distinct submedian ridges flanked by setiferous punctations; opposable surface with row of 10 tubercles along proximal two-thirds of finger, fourth from base largest; additional tubercle present on lower level near base of distal third; double row of minute denticles extending proximally from distal end of third tubercle, interrupted by fourth through tenth tubercles. Dorsal and ventral surfaces of dactyl with median longitudinal ridges flanked by setiferous punctations; opposable margin with row of 16 tubercles, fifth largest; double row of denticles extending proximally from distal end to fifth tubercle, interrupted by each of sixth through sixteenth tubercles; mesial surface with irregular rows of tubercles on proximal two-thirds, reduced to single row distally. Fingers with distal tubercles very small and inconspicuous; terminating in large, acute, corneous tips.

Carpus with deep oblique furrow dorsally; mesial surface with large procurved spine near midlength, 9 and 10 scattered tubercles on left and right cheliped, respectively; dorsal surface with 9 tubercles (right with 12) and additional acute one at distomesial margin; distoventral margin with 2 acute tubercles (median one on left broken); podomere otherwise punctate.

Dorsodistal surface of left merus with 2 acute to subacute tubercles (right with 3); ventral surface with lateral row of 2 corneous-tipped spines, proximal one smaller, and mesial row of 9 spines, some corneous, decreasing in size proximally. Ischium with single small corneous-tipped tubercle on ventromesial margin.

Hook on ischium of third pereiopod only (Fig. 1*d*); hook simple, overreaching basioischial articulation and not opposed by tubercle on basis. Coxae of fourth and fifth pereiopods without caudomesial boss. (See *Measurements.*)

First pleopods (Fig. 1*b, g*) reaching bases of second pair of pereiopods when abdomen flexed. (See *Diagnosis* for description.)

*Allotypic female*: Differing from holotype in following respects: areola constituting 28.7 percent of entire length of carapace (37.8 percent of postorbital carapace length) and 5.7 times longer than broad. Postorbital ridges terminating in more acute spines. Left chela (right missing) distinctly narrower and shorter with mesial surface of palm

bearing 7 tubercles in primary and 4 in secondary rows. Propodus with opposable margin bearing row of 9 tubercles, fifth from base largest; additional tubercle present on lower level; double row of denticles extending proximally from distal tip to fifth tubercle, interrupted by sixth through eleventh. Dactyl with opposable margin bearing 11 tubercles, first and fourth from base largest; double row of denticles extending proximally from tip to fifth tubercle, interrupted by sixth through eleventh. Carpus of left cheliped with mesial surface possessing corneous-tipped, procurved spine; distoventral margin with 2 corneous-tipped spines. Left merus with ventral surface bearing mesial row of 10 spines, some corneous-tipped.

Sternum between third and fourth pereiopods broadly V-shaped. Annulus ventralis (Fig. 1*j*) symmetrical and firmly fused cephalically to sternum; cephalic portion elevated with shallow, longitudinal, median trough flanked by low ridges, latter produced laterally at midlength as transverse, elevated ridges; fossa centrally located; caudal half bearing ?-shaped sinistral sinus. Postannular sclerite about two-thirds as wide as annulus. First pleopods of female uniramous and reaching midlength of annulus when abdomen flexed.

*Morphotypic male, form II*: Differing from holotype in following respects: areola constituting 28.9 percent of entire length of carapace (39.7 percent of postorbital carapace length), and 7.2 times longer than broad with 2 punctations across narrowest part. Postorbital ridge with more acute spine cephalically. Mesial surface of palm of right chela (left regenerated) with 7 tubercles in primary and 4 in secondary rows; propodus bearing 11 tubercles on opposable margin, additional one on lower level. Dactyl with opposable margin possessing 15 tubercles; double row of denticles extending proximally from tip to third tubercle, interrupted by fourth through fifteenth. Carpus of right cheliped with mesial surface bearing corneous-tipped, procurved spine and 12 scattered tubercles. Merus with single corneous-tipped tubercle representing usual ventrolateral row. Right ischium with single non-cornified tubercle on ventromesial margin.

Hook on ischium of third pereiopod much reduced, not overreaching basioischial articulation. First pleopod (Fig. 1*c*, *f*) of uniform texture, subequal and neither element corneous. Distal ends of both elements recurved at angle of approximately 40 degrees.

*Type-locality*: Robinson Creek at Tennessee State Highway 57 (Tennessee River system), Hardin County, Tennessee. The creek varies from 6 to 15 feet in width and as much as 3 feet in depth in pools and less than 1 foot at the riffles. During several visits to the creek, the water ranged from clear to slightly turbid. The substrate is mostly sand with gravel in the riffles, several small to moderately sized rocks below the bridge site and numerous pockets of leaf litter in the pools and around obstructions in the runs. Mixed deciduous trees line the banks of this small creek. Robinson Creek is also the type-locality for *Orconectes wrighti* Hobbs (1948).

*Disposition of types*: The holotypic male, form I (USNM 146583), the allotype (USNM 146584) and the morphotypic male, form II (USNM 146585) are deposited in the National Museum of Natural History, Smithsonian Institution. Paratypes consisting of 8 ♂I, 6 ♂II, 9 ♀, 3 ♂ juv. and 11 ♀ juv. are in the Smithsonian Institution; 2 ♂I and 2 ♀ are deposited in the Tulane University Museum; and 8 ♂I, 16 ♂II, 19 ♀, 2 ♀ eggs, 1 ♂ juv. and 4 ♀ juv. are in the collection of the senior author.

*Range and specimens examined*: This new species of crayfish is known from Tennessee and Mississippi. In Tennessee *Orconectes etnieri* has been collected from tributaries draining the west bank of the Tennessee River from Robinson Creek northward to Snake Creek in Hardin and McNairy counties. In waters flowing westward into the Mississippi River, it has been collected from the Forked Deer, Hatchie and Loosahatchie River systems in Tennessee and Mississippi. A crayfish of the Mississippi Embayment province, it is absent from the sluggish waters that characterize the Mississippi River Floodplain section.

The following material is designated as paratypes: TENNESSEE. HARDEMAN COUNTY. Dry Branch at Tennessee State Highway 125, 1.3 miles south of intersection with U.S. Highway 64 (Hatchie River system via Spring Creek). C. E. Comiskey, D. A. Etnier and M. Reese. 18 October 1968. 6 ♂I, 3 ♀. HARDIN COUNTY. Robinson Creek at Tennessee State Highway 57 and two additional localities approximately 0.7 and 1.2 air miles upstream (Tennessee River system). P. Yokley, Jr., and R. W. B. 15 March 1971. 5 ♂I, 6 ♂II, 6 ♀, 1 ♀ eggs, 1 ♂ juv. and 4 ♀ juv.; Robinson Creek at Tennessee State Highway 57 and single additional locality approximately 0.7 air miles upstream. J. D. Way and R. W. B. 14 March 1972. 2 ♂I, 7 ♂II, 10 ♀, 2 ♂ juv. and 6 ♀ juv.; Snake Creek at Tennessee State Highway 22 (Tennessee River system). C. E. Comiskey, D. A. Etnier and M. Reese. 19 October 1968. 2 ♂I and 2 ♀. MCNAIRY COUNTY. Snake Creek, at County Road 8235, 2.0 miles west of intersection with County Road 8083. T. Carson, B. Clark, M. Hughes and G. A. Schuster. 1 March 1974. 3 ♂I, 10 ♂II, 13 ♀ and 1 ♀ eggs.

*Variation*: The most significant variation within the species occurs in the annulus ventralis. The anterior ridges bordering the median trough of the annulus may be lacking, and in some populations the trough is broader and more deeply excavated.

*Size*: The largest specimen available is a second form male with a total carapace length of 32.5 mm (postorbital carapace length 24.0 mm). The smallest first form male has corresponding lengths of 18.4 and 13.9 mm. The smaller of the two females with eggs has a total carapace length of 24.6 mm. (postorbital carapace length 18.6 mm).

*Color notes*: Cephalothorax and abdomen mottled with browns and a pair of dorsolateral and submedian broken, dark brown stripes on abdomen extending onto cephalothorax as darker mottled dorsolateral areas. Stripes and dark dorsolateral mottling may be less obvious and faded in some individuals. Branchiostegites and hepatic region otherwise light

TABLE 1. Measurements (mm) of *Orconectes etnieri*

| | Holotype | Allotype | Morphotype |
|---|---|---|---|
| Carapace | | | |
| Height | 14.0 | 12.7 | 13.4 |
| Width | 17.0 | 13.9 | 15.6 |
| Total length of carapace | 31.3 | 29.6 | 32.5 |
| Postorbital carapace length | 23.8 | 22.5 | 24.0 |
| Areola | | | |
| Width | 1.5 | 1.5 | 1.3 |
| Length | 9.0 | 8.5 | 9.4 |
| Rostrum | | | |
| Width | 4.5 | 3.2 | 4.3 |
| Length | 7.5 | 7.1 | 8.5 |
| Chela | | | |
| Length, mesial margin palm | 9.2 | 6.0 | 8.6 |
| Width, palm | 12.6 | 7.2 | 10.1 |
| Length, lateral margin | 30.2 | 18.8 | 26.5 |
| Length, dactyl | 18.7 | 11.0 | 15.9 |

brown to white. Rostral margins, postorbital ridges and lateral margins of antennal scales darker brown than basic color of body. Ventral aspects of cephalothorax and abdomen white.

Chelae mottled to concolorous brown dorsally with lighter proximolateral area; white to cream ventrally. Tubercles along opposable margins of fingers yellow to cream. Distal ends of fingers red in young, often orange or yellow in adults. Pereiopods mottled brown dorsally; fading to cream or white ventrally. Distal podomeres darker dorsally than proximal ones.

*Life history notes*: First form males have been collected during the months of March, July and October. Two females bearing eggs were collected, one each on 15 March 1971 and 1 March 1974.

*Ecological notes*: *Orconectes etnieri* commonly inhabits the leaf litter which has collected in pools or above obstructions, such as fallen branches, in the runs. At the type-locality *O. etnieri* shared its preferred habitat with *Procambarus acutus acutus* (Girard 1852), *P. ablusus*, *Orconectes validus* (Faxon 1914), *O. wrighti*, *Cambarus striatus* Hay (1902) and occasional individuals of the primary burrowing crayfish *C. diogenes* Girard (1852). *Orconectes wrighti* was more common under rocks that littered the riffles. *Cambarus striatus* and *Cambarus diogenes* were common burrowers in the stream bank.

Collected along with *Orconectes etnieri* in one or more localities were *Procambarus ablusus* (Hatchie, Forked Deer and Tennessee River sys-

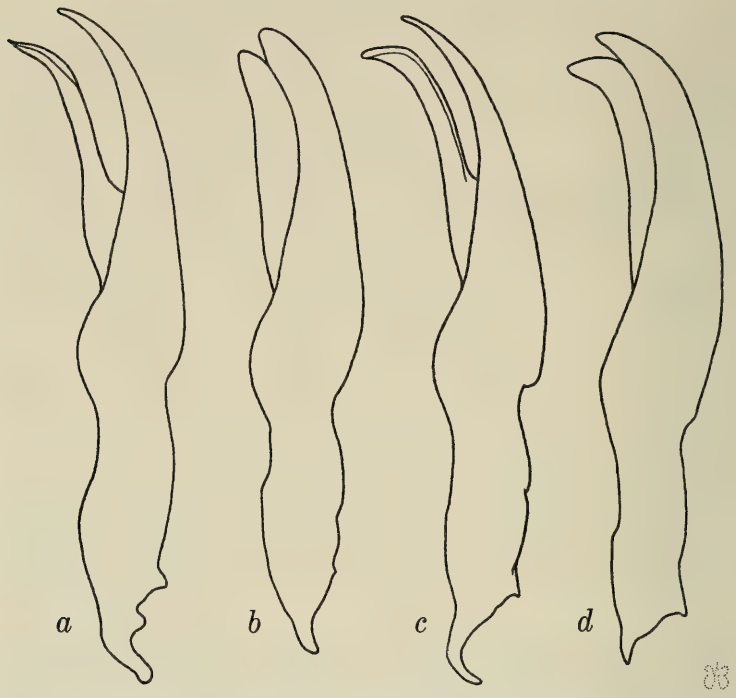



FIG. 2. Lateral view of left first pleopods of two species of *Orconectes*. *a*, First form male, *O. etnieri*; *b*, Second form male, *O. etnieri*; *c*, First form male, *O. validus*; *d*, Second form male, *O. validus*.

tems), *P. a. acutus* (Tennessee River system), *Cambarus striatus* (Hatchie, Forked Deer, Loosahatchie and Tennessee River systems), *Cambarus diogenes* (Hatchie and Tennessee River systems), *Orconectes p. palmeri* (Faxon 1884) (Loosahatchie River system), *O. placidus* (Hagen 1870), *O. validus* and *O. wrighti* (Tennessee River system).

When *Procambarus ablusus* was described from the Hatchie River system in Mississippi and Tennessee, it was regarded by Penn as an uncommon species and remains so in museum collections. *Procambarus ablusus* does appear to be rare in the Hatchie River system but in some localities in the Forked Deer River basin to the north it is very common.

*Orconectes wrighti* is also a little known crayfish with an apparently restricted range. In addition to its presence in the type-locality, a population of this rare species occurs in a stream flowing through Hardin and McNairy counties, Snake Creek, a tributary of the Tennessee River. Its range probably does not exceed the area bordered by these two localities and it may not occur outside of the two creek systems.

*Relationships*: *Orconectes etnieri* has its closest affinities with *O. validus* from which it differs primarily in the morphology of the male gonopod. In *O. etnieri* the terminal elements are recurved at the same angle (Fig. 2*a, b*) while in *O. validus* the angles differ, with the mesial process recurved at approximately 90 degrees (Fig. 2*c, d*). The rostrum of *O. etnieri* is much flatter in comparison to the deeply excavate one of *O. validus*. For the most part the two species occupy mutually exclusive ranges. *Orconectes validus* occurs in the Tennessee River system in streams draining the Highland Rim section downstream to Benton County, Tennessee. A single female from Montgomery County, Tennessee, (Cumberland River system) may also be a member of this species possibly indicating a larger range. *Orconectes etnieri* is known from only a small part of the Tennessee River system in Hardin and McNairy counties, Tennessee, (Robinson Creek and Snake Creek) and very possibly occurs in nearby tributaries of the Tennessee River in Mississippi. Most of the range of *O. etnieri*, however, embraces westward flowing tributaries of the Mississippi River from which *O. validus* is absent. Both species were collected syntopically at the type-locality.

*Etymology*: We take great pleasure in naming this new species of crayfish in honor of David A. Etnier, University of Tennessee, Knoxville, for his many contributions to our knowledge of Tennessee crayfishes and especially his enthusiam in collecting primary burrowing species.

*Acknowledgments*: We are indebted to Joseph F. Fitzpatrick, Jr., University of South Alabama, Mobile, who with Horton H. Hobbs, Jr., originally noted the uniqueness of this new species and permitted us the honor of naming it after our former major professor. To Horton H. Hobbs, Jr., we are as always indebted for his kindness and valuable assistance and for reviewing the manuscript. To David A. Etnier and his students who helped collect much of the material upon which this description is based we owe thanks, especially to those who surveyed the West Tennessee fish fauna: George Boronow (Forked Deer River system), Byron Clark (Tennessee River system), William Dickinson (Obion River system) and Wayne Starnes (Hatchie River system). Appreciation is extended to the Smithsonian Institution for providing the senior author with a Smithsonian Postdoctoral Fellowship permitting the opportunity to describe this new species.

## Literature Cited

Faxon, Walter. 1884. Descriptions of new species of *Cambarus*, to which is added a synonymical list of the known species of *Cambarus* and *Astacus*. Proc. Amer. Acad. Arts and Sci. 20:107–158.

———. 1914. Notes on the crayfishes in the United States National Museum and the Museum of Comparative Zoology with descriptions of new species and subspecies to which is appended a catalogue of the known species and subspecies. Mem. Mus. Comp. Zool., Harvard Coll. 40(8):351–427.

Girard, Charles. 1852. A revision of the North American Astaci, with observations on their habits and geographical distribution. Proc. Acad. Natur. Sci., Philadelphia 6:87–91.

Hagen, Hermann A. 1870. Monograph of the North American Astacidae. Illus. Cat. Mus. Comp. Zool., Harvard Coll. 3:viii + 109 pp., 11 pls.

Hay, William Perry. 1902. Observations on the crustacean fauna of Nickajack Cave, Tennessee, and vicinity. Proc. U.S. Nat. Mus. 25(1292):417–439.

Hobbs, Horton H., Jr. 1948. A new crayfish of the genus *Orconectes* from southern Tennessee (Decapoda, Astacidae). Proc. Biol. Soc. Washington 61(15):85–91.

Penn, George Henry. 1963. A new crawfish from the Hatchie River in Mississippi and Tennessee (Decapoda, Astacidae). Proc. Biol. Soc. Washington 76(15):121–125.

QH
1
B4X
NH

3, No. 44, pp. 469–488 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

LIBRARIES
1976

# *PERCINA (IMOSTOMA) TANASI*, A NEW PERCID FISH FROM THE LITTLE TENNESSEE RIVER, TENNESSEE

By David A. Etnier
*Department of Zoology, University of Tennessee, Knoxville, Tenn. 37916*

The Little Tennessee River begins in Macon County, North Carolina, and flows northwest to enter the Tennessee River near Lenoir City, Loudon County, Tennessee. The flow of the Little Tennessee River is interrupted by Fontana Reservoir, a large warmwater impoundment in Swain and Graham counties, North Carolina. Tailwaters of Fontana Reservoir are consistently cold and well suited to a recreational trout fishery. The cold water habitat continues through Cheoah, Calderwood, and Chilhowee reservoirs. Below Chilhowee Reservoir a trout fishery persists for about 21 river km, ending approximately 2.5 river km above the U.S. Highway 411 bridge, Monroe County, Tennessee. Although trout occur sporadically in the lower 32 km of river, warmwater fishes are predominant.

Records indicate that the original fish fauna of the Little Tennessee River system was rich. Among the more interesting species known from this system are an undescribed darter of the subgenus *Catonotus* (R. E. Jenkins, in lit.), *Hybopsis monacha* (Cope), *Cycleptus elongatus* (Lesueur), and *Percina burtoni* Fowler. *Noturus baileyi* Taylor, a madtom that is likely extinct, is known only from a rough fish removal operation in Abrams Creek, tributary to the Little Tennessee River (Taylor, 1969). A number of reports of lake sturgeon (*Acipenser fulvescens* Rafinesque) from recent sightings and captures in the river suggest the continued existence of what is possibly a reproducing population of this vanishing species in the lower Little Tennessee River. A reasonable number of fish

collection records are available from the tributaries and headwater portions of the system, and from the 21 km of river utilized as a trout fishery below Chilhowee Dam. The lower 32 km of the Little Tennessee River remained uncollected until recently. It seemed possible that (despite environmental changes that have taken place over the years) some elements of the original main channel fish fauna might persist in the lower portion of the river. An additional impoundment, Tellico Reservoir, is under construction by the Tennessee Valley Authority, and would innundate virtually all of the river remaining below Chilhowee Dam. With this in mind, Robert A. Stiles and I visited the river at Coytee Spring, River Mile 7, Loudon County, Tennessee, on 12 August 1973, in an attempt to survey the fish fauna with the aid of face masks and snorkels. Although very few fishes were seen, a single specimen of a very unusual darter was observed and "scooped up" by hand by the author. Subsequent examination of this specimen indicated that it was a new species of the genus *Percina,* subgenus *Imostoma.*

In the genus *Percina,* the subgenus *Imostoma* had until recently been envisioned as containing two species, *P. shumardi* (Girard) and *P. uranidea* (Jordan and Gilbert). Three specimens collected in Shoal Creek, tributary to the Etowah River (Mobile Bay drainage), Cherokee County, Georgia, by Don Scott and O. Tyson, were recognized by J. D. Williams in 1966 as representing a distinct species allied with *P. uranidea.* Impoundment of Alatoona Reservoir apparently eliminated the population. Stiles and I collected a specimen of this species in the Conasauga River, Polk County, Tennessee, in 1968. Approximately 60 additional specimens have now been collected from the latter stream, and the description of this species by Williams and Etnier is in preparation.

In 1970 I examined some specimens at Tulane University from the Ozark region collected by R. C. Cashner and B. A. Thompson. These distinctive specimens, collected with what was then known as *P. uranidea,* appeared to be a new species. Subsequent examination of the types of *P. uranidea* and its supposed junior synonym *P. ouachitae* (Jordan and Gilbert) by Thompson revealed that their "new" species was identical

with the types of *P. uranidea,* and the types of *P. ouachitae* were identical with specimens then being referred to as *P. uranidea* (Thompson, in lit.). A paper concerning the status of *P. uranidea* and *P. ouachitae* is being prepared by Thompson and Cashner. Examination of the specimen from the Little Tennessee River suggested that its affinities were with true *P. uranidea* rather than with *P. ouachitae, P. shumardi,* or the undescribed species from the Conasauga River. Further studies confirmed this view and indicated that the Little Tennessee River population represented a species distinct from *P. uranidea.*

## The Subgenus *Imostoma*

The subgenus *Imostoma* currently includes the following five species: *P. shumardi* (Girard), which lacks distinct dorsal saddles; and four species with saddles—*P. uranidea* (Jordan and Gilbert), restricted now to the White and Saline river systems, Arkansas, but formerly occurring in the Wabash River, Indiana; *P. ouachitae* (Jordan and Gilbert), widespread in the lower Mississippi River valley and in the Gulf Coastal drainages; the undescribed species from the Conasauga River; and the new species from the Little Tennessee River, described herein.

Page (1974) presented a brief diagnosis of the subgenus *Imostoma* based on *P. shumardi,* the undescribed species from the Conasauga River, and *P. uranidea* from a "ditch" in Missouri. His *P. uranidea* specimens were likely *P. ouachitae,* since *P. uranidea* is extremely rare in Missouri, and appears to be restricted to swift water in moderate size rivers. *P. ouachitae* does occur in ditch-type habitats. The inclusion of two additional species in the subgenus (*P. uranidea* and *P. tanasi*), plus examination of extensive material of the three species considered by Page, necessitates modification of the diagnosis, as follows. A "midbelly row of modified (enlarged and strongly toothed) scales" develops on individuals of all five species. These modified midventral scales are most conspicuous in large adults, and may be lacking in juveniles and small adults. In nuptial males of *P. uranidea* there is a more or less well developed band of exposed but scarcely modified

ctenoid scales extending from the ventral prepectoral area transversely across the middle of the breast. In the other four species embedded cycloid and occasionally a few exposed ctenoid scales are present on the breast in many individuals. These are most conspicuous in nuptial males, and are usually confined to the posterior half of the breast.

### Key to the Species of the Subgenus *Imostoma*

1. Dorsal saddles absent ..... *Percina shumardi* (Girard)
   Four or five distinct dorsal saddles present ..... 2
2. Anteriormost dorsal saddle entirely in front of dorsal fin ..... *Percina* species
   Anteriormost dorsal saddle beneath dorsal fin ..... 3
3. Posterior margin of fourth dorsal saddle over dorsal insertion of caudal fin; fifth dorsal saddle absent; anal soft rays 11–12 (extremes 10–13) ..... 4
   Posterior margin of fourth dorsal saddle anterior to dorsal insertion of caudal fin; fifth saddle adjacent to dorsal insertion of caudal fin, moderately developed; anal soft rays 10–11 (9–12) ..... *Percina ouachitae* (Jordan and Gilbert)
4. Anal rays modally 11; pectoral fins long and pointed, overlying lateral-line scale 19–24 (males) or 17–23 (females and juveniles); pelvic fins 22% of standard length or longer in males, 20% of standard length or longer in females and juveniles; nuptial males with tubercles on pelvic spine and adjacent four soft rays ..... *Percina uranidea* (Jordan and Gilbert)
   Anal rays modally 12; pectoral fins shorter and more rounded, overlying lateral-line scale 17–19 (males) or 15–18 (females and juveniles); pelvic fins less than 22% of standard length in males, less than 20% of standard length in females and juveniles; nuptial males with pelvic fin tubercles confined to the four median rays ..... *Percina tanasi* new species

### Methods

Measurements and counts (Tables 1–8) follow the methods of Hubbs and Lagler (1958) unless defined below. Measure-

ments were made with a needle-point divider and read to the nearest 0.1 mm. Head length was measured from the tip of the snout to the tip of the membranous extension of the operculum. Orbital diameter and interorbital width were measured between the fleshy coverings of the bones delimiting these areas. Trans-pelvic width was the measurement between the outer edges of the parallel pelvic spines. Saddle widths were measured along the dorsal midline and the saddle position from the occiput. The lateral-line scale under the tip of the pectoral fin (Table 3) was obtained by counting from the head to the fin tip when pressed against the lateral midline.

## Material Studied

The number of specimens appears in parentheses after the catalog number. The following abbreviations have been used: SL (Standard length), TU (Tulane University), UT (University of Tennessee), USNM (National Museum of Natural History, Smithsonian Institution), CU (Cornell University), FSM (Florida State Museum), INHS (Illinois Natural History Survey), NLU (Northeastern Louisiana State University), UAIC (University of Alabama Ichthyological Collection), UMMZ (Museum of Zoology, University of Michigan), OAM (Oklahoma State University), HWR (Henry W. Robison collection).

**Percina tanasi**, new species

Snail Darter

Figure 1

*Type-specimens*: Holotype, TU 90858, an adult male, 59.1 mm SL, Little Tennessee River at Coytee Spring, River Mile 7, Loudon County, Tennessee, 6 Nov. 1973, G. F. Boronow, B. F. Clark, Jr., D. A. Etnier, R. L. Hensen, W. C. Starnes, B. A. Thompson. Allotype female, TU 90859, 54.6 mm SL, same data as holotype. Paratypes taken with the holotype are TU 83994 (2) and USNM 214697 (2). Additional paratypes taken at the type-locality are CU 64754 (5), FSM 20852 (5), INHS 75000 (5), NLU 32057 (5), UAIC 5020.01 (5), and UMMZ 197413 (5), all 16 Aug. 1973; USNM 214698 (5), 4 Oct. 1974; UT 91.803 (1), 12 Aug. 1973; UT 91.1074 (10), 23 April 1975. An additional paratype, OAM 9536 (1), is from River Mile 15, main channel side of Davis Island, Little Tennessee River, Loudon County, Tenn., 4 Oct. 1974.

TABLE 1. Measurements of *Percina tanasi* and *P. uranidea* expressed in thousandths of standard length. ($\bar{x}$ = mean, W = range, $S_x$ = standard deviation, N = sample size, M = males, F = females, J = juveniles and subadults)

| Characters | | *P. tanasi* | | | | *P. uranidea* (White R.) | | | | *P. uranidea* (Saline R.) | | | | *P. uranidea* (Wabash R.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | W | $S_x$ | N | $\bar{x}$ | W | $S_x$ | N | $\bar{x}$ | W | $S_x$ | N | $\bar{x}$ | W | $S_x$ | N |
| Minimum interorbital width | M | 51.54 | 44–58 | 3.80 | 13 | 47.30 | 44–52 | 2.98 | 10 | 43.50 | 40–49 | 2.92 | 10 | 45.00 | 39–49 | 3.85 | 6 |
| | F | 51.18 | 46–61 | 4.38 | 11 | 45.70 | 41–50 | 3.06 | 10 | 44.11 | 40–49 | 3.18 | 9 | 41.50 | 40–43 | | 2 |
| | J | 49.47 | 42–55 | 3.13 | 19 | 49.70 | 45–55 | 2.83 | 10 | 44.20 | 34–50 | 5.41 | 10 | | | | |
| Width below origin of soft dorsal fin | M | 132.46 | 119–147 | 8.77 | 13 | 116.10 | 107–126 | 6.11 | 10 | 123.10 | 114–133 | 5.43 | 10 | 119.17 | 114–126 | 4.12 | 6 |
| | F | 135.91 | 127–149 | 7.24 | 11 | 124.20 | 108–137 | 8.98 | 10 | 121.10 | 113–129 | 6.26 | 10 | 117.50 | 112–123 | | 2 |
| | J | 133.68 | 124–145 | 5.28 | 19 | 124.00 | 115–132 | 4.88 | 10 | 121.00 | 115–129 | 4.78 | 10 | | | | |
| Width below origin of saddle 3 | M | 95.69 | 76–109 | 8.40 | 13 | 80.70 | 74–88 | 5.06 | 10 | 90.30 | 84–96 | 4.52 | 10 | 82.57 | 75–88 | 5.09 | 7 |
| | F | 99.91 | 93–113 | 6.02 | 11 | 87.80 | 81–100 | 7.89 | 10 | 89.00 | 80–100 | 5.54 | 10 | 82.50 | 80–85 | | 2 |
| | J | 101.37 | 93–109 | 4.30 | 19 | 95.50 | 90–102 | 4.81 | 10 | 95.10 | 89–102 | 3.84 | 10 | | | | |
| Pectoral fin length | M | 242.69 | 215–276 | 16.95 | 13 | 285.46 | 252–326 | 18.21 | 28 | 287.50 | 264–304 | 11.04 | 18 | 269.33 | 257–279 | 9.40 | 6 |
| | F | 218.82 | 195–238 | 13.49 | 11 | 266.39 | 234–291 | 12.62 | 23 | 255.73 | 223–274 | 14.83 | 11 | 253.00 | 251–255 | | 2 |
| | J | 207.79 | 192–224 | 8.85 | 19 | 248.75 | 223–274 | 10.65 | 24 | 240.90 | 230–253 | 6.12 | 10 | | | | |
| Pelvic fin length | M | 200.00 | 165–223 | 15.68 | 13 | 228.89 | 218–244 | 7.62 | 19 | 231.12 | 211–248 | 11.26 | 17 | 221.60 | 206–232 | 8.60 | 7 |
| | F | 184.27 | 158–199 | 12.75 | 11 | 219.89 | 207–242 | 9.38 | 18 | 223.18 | 208–234 | 9.38 | 11 | 216.00 | 215–217 | | 2 |
| | J | 180.42 | 160–194 | 7.90 | 19 | 210.58 | 187–226 | 10.46 | 24 | 225.80 | 217–232 | 5.88 | 10 | | | | |
| Width of first saddle | M | 64.20 | 52–84 | 9.24 | 10 | 45.40 | 34–57 | 8.02 | 10 | 57.00 | 42–71 | 9.58 | 10 | 46.67 | 38–58 | 6.47 | 6 |
| | F | 63.00 | 41–82 | 11.85 | 10 | 48.89 | 31–61 | 10.42 | 9 | 56.10 | 46–65 | 7.08 | 10 | 31.00 | | | 1 |
| | J | 59.21 | 41–76 | 9.46 | 19 | 55.10 | 45–58 | 4.23 | 10 | 61.70 | 51–82 | 8.88 | 10 | | | | |
| Width of second saddle | M | 55.69 | 40–79 | 12.00 | 13 | 36.70 | 22–51 | 7.60 | 10 | 53.80 | 36–71 | 11.68 | 10 | 48.86 | 39–58 | 6.41 | 7 |
| | F | 61.91 | 47–75 | 9.33 | 11 | 42.20 | 34–50 | 4.13 | 10 | 53.00 | 45–63 | 6.56 | 10 | 47.00 | 43–55 | | 2 |
| | J | 56.84 | 40–64 | 6.61 | 19 | 51.10 | 42–60 | 6.45 | 10 | 61.90 | 56–78 | 6.85 | 10 | | | | |
| Width of third saddle | M | 62.15 | 46–81 | 10.42 | 13 | 30.50 | 19–41 | 6.70 | 10 | 49.70 | 33–67 | 13.69 | 10 | 49.14 | 37–63 | 8.63 | 7 |
| | F | 64.45 | 50–80 | 9.68 | 11 | 29.40 | 18–38 | 6.67 | 10 | 49.10 | 36–67 | 10.16 | 10 | 43.00 | 38–48 | | 2 |
| | J | 63.74 | 42–79 | 8.12 | 19 | 47.10 | 40–55 | 5.57 | 10 | 54.40 | 29–79 | 12.48 | 10 | | | | |
| Width of fourth saddle | M | 42.00 | 30–60 | 8.60 | 13 | 25.40 | 13–33 | 6.02 | 10 | 37.10 | 28–54 | 8.89 | 10 | 33.14 | 24–43 | 7.29 | 7 |
| | F | 44.36 | 33–60 | 8.37 | 11 | 28.10 | 21–43 | 7.36 | 10 | 41.80 | 34–51 | 6.39 | 10 | 35.00 | 26–44 | | 2 |
| | J | 46.21 | 24–59 | 8.14 | 19 | 36.20 | 30–45 | 5.29 | 10 | 48.30 | 41–60 | 5.85 | 10 | | | | |

TABLE 2. Frequency of lateral-line scales in *Percina tanasi* and *P. uranidea.*

| | Number of lateral-line scales | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | N | $\bar{x}$ |
| *Percina tanasi* | | | 2 | 8 | 5 | 10 | 5 | 6 | 7 | 4 | 6 | 1 | | | 1 | 55 | 52.3 |
| *P. uranidea* | | | | | | | | | | | | | | | | | |
| White River system | 1 | 4 | 2 | 7 | 18 | 15 | 16 | 13 | 8 | 4 | | | | | | 88 | 51.3 |
| Saline River system | | 1 | 2 | 4 | 10 | 9 | 18 | 19 | 11 | 9 | 4 | 5 | 1 | | 1 | 94 | 52.7 |
| Wabash River system | | 1 | 2 | | 1 | 1 | 1 | 2 | 1 | | | | | | | 9 | 50.7 |

TABLE 3. Lateral-line scale beneath tip of left pectoral fin in *Percina tanasi* and *P. uranidea*

| | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | N | $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Percina tanasi*, males | | | | 1 | 2 | 8 | 6 | 2 | | | | | | 19 | 18.3 |
| *P. uranidea, males* | | | | | | | | | | | | | | | |
| White River system | | | | | | 1 | 1 | 3 | 5 | 4 | | | | 14 | 20.7 |
| Saline River system | | | | | | 1 | 3 | 9 | 8 | 5 | 3 | 2 | | 31 | 20.7 |
| Wabash River system | | | | | | | 3 | 3 | | | | | | 6 | 19.5 |
| *Percina tanasi*, females and juveniles | 2 | | 9 | 9 | 11 | 5 | | | | | | | | 36 | 16.2 |
| *P. uranidea*, females and juveniles | | | | | | | | | | | | | | | |
| White River system | | | | 1 | 2 | 16 | 11 | 10 | 9 | 6 | 3 | 1 | 1 | 60 | 19.8 |
| Saline River system | | | | | 4 | 7 | 9 | 12 | 5 | 3 | | | | 40 | 19.4 |
| Wabash River system | | | | | 1 | | | 1 | | | | | | 2 | 18.5 |

TABLE 4. Frequency of transverse scale rows (counted from first anal spine obliquely forward to dorsal fin) and minimum scale rows around caudal peduncle for *Percina tanasi* and *P. uranidea*.

| | Transverse Scale Rows | | | | | | | | Scales Around Caudal Peduncle | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14 | 15 | 16 | 17 | 18 | 19 | N | $\bar{x}$ | 18 | 19 | 20 | 21 | 22 | N | $\bar{x}$ |
| *Percina tanasi* | | 6 | 22 | 18 | 8 | 1 | 55 | 16.6 | | 12 | 32 | 9 | 2 | 55 | 20.0 |
| *P. uranidea* | | | | | | | | | | | | | | | |
| White River system | | 21 | 23 | 13 | 1 | | 58 | 16.2 | 6 | 18 | 32 | 4 | 2 | 58 | 20.2 |
| Saline River system | 1 | 6 | 18 | 13 | 6 | 1 | 45 | 16.4 | 1 | 9 | 23 | 12 | | 45 | 20.0 |
| Wabash River system | 1 | 5 | 2 | 1 | | | 9 | 15.3 | 1 | 4 | 4 | | | 9 | 19.3 |

TABLE 5. Frequency of spines and soft rays in dorsal fins of *Percina tanasi* and *P. uranidea*.

| | Dorsal spines | | | | | | Dorsal Soft Rays | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IX | X | XI | XII | N | $\bar{x}$ | 13 | 14 | 15 | 16 | 17 | 18 | N | $\bar{x}$ |
| *Percina tanasi* | 1 | 27 | 22 | 4 | 54 | 10.5 | 1 | 10 | 22 | 17 | 2 | | 52 | 15.2 |
| *P. uranidea* | | | | | | | | | | | | | | |
| White River system | 3 | 25 | 37 | 2 | 67 | 10.4 | | 12 | 43 | 6 | | | 61 | 14.9 |
| Saline River system | | 21 | 21 | 2 | 44 | 10.6 | | 10 | 26 | 8 | | 1 | 45 | 15.0 |
| Wabash River system | 1 | 2 | 6 | | 9 | 10.6 | 1 | 2 | 6 | | | | 9 | 14.6 |

TABLE 6. Frequency of soft anal rays and principal caudal rays in *Percina tanasi* and *P. uranidea*.

| | Anal Soft Rays | | | | | | Caudal Rays | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 11 | 12 | 13 | N | $\bar{x}$ | 15 | 16 | 17 | N | $\bar{x}$ |
| *Percina tanasi* | 2 | 15 | 36 | 1 | 54 | 11.7 | 6 | 42 | 3 | 51 | 15.9 |
| *P. uranidea* | | | | | | | | | | | |
| White River system | 5 | 32 | 15 | | 52 | 11.2 | 6 | 27 | 14 | 47 | 16.2 |
| Saline River system | 3 | 40 | 9 | 1 | 53 | 11.2 | 2 | 21 | 22 | 45 | 16.5 |
| Wabash River system | 3 | 5 | 1 | | 9 | 10.8 | | | | | |

TABLE 7. Frequency of pectoral fin rays in *Percina tanasi and P. uranidea*

| | Left Pectoral Rays | | | | | Right Pectoral Rays | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 | 14 | 15 | N | $\bar{x}$ | 13 | 14 | 15 | 16 | N | $\bar{x}$ |
| *Percina tanasi* | 10 | 37 | 4 | 51 | 13.9 | 10 | 38 | 2 | | 50 | 13.8 |
| *P. uranidea* | | | | | | | | | | | |
| White River system | 9 | 43 | 2 | 54 | 13.9 | 12 | 36 | 6 | 1 | 55 | 13.9 |
| Saline River system | 5 | 34 | 6 | 45 | 14.0 | 5 | 35 | 5 | | 45 | 14.0 |
| Wabash River system | 4 | 4 | | 8 | 13.5 | 1 | 5 | | | 6 | 13.8 |

TABLE 8. Measurements of *Percina tanasi* expressed in thousandths of standard length. ($\bar{x}$ = mean, W = range, $S_x$ = standard deviation, N = sample size, M = males, F = females, J = juveniles and subadults)

| Characters | | $\bar{x}$ | W | $S_x$ | N |
|---|---|---|---|---|---|
| Head length | M | 288.00 | 272–304 | 9.40 | 13 |
| | F | 286.91 | 282–293 | 4.23 | 11 |
| | J | 289.89 | 278–307 | 7.18 | 19 |
| Orbit diameter | M | 71.92 | 66–80 | 3.62 | 13 |
| | F | 72.91 | 68–76 | 2.21 | 11 |
| | J | 74.32 | 69–78 | 2.52 | 19 |
| Maximum body width | M | 166.46 | 142–195 | 13.73 | 13 |
| | F | 170.73 | 153–200 | 12.27 | 11 |
| | J | 155.84 | 141–172 | 8.66 | 19 |
| Caudal peduncle depth | M | 80.76 | 74–86 | 3.30 | 13 |
| | F | 82.70 | 73–88 | 4.27 | 10 |
| | J | 83.32 | 78–86 | 2.79 | 19 |
| Caudal fin length | M | 200.23 | 177–224 | 12.38 | 13 |
| | F | 193.09 | 185–199 | 4.69 | 11 |
| | J | 196.74 | 175–206 | 7.71 | 19 |
| Longest dorsal spine | M | 119.46 | 100–146 | 15.08 | 13 |
| | F | 117.10 | 82–147 | 22.56 | 10 |
| | J | 124.72 | 99–154 | 18.25 | 18 |
| Longest dorsal soft ray | M | 152.08 | 135–173 | 11.02 | 12 |
| | F | 139.80 | 132–151 | 6.97 | 10 |
| | J | 138.56 | 127–154 | 7.23 | 18 |
| Length of anal spine | M | 72.85 | 61–83 | 6.39 | 13 |
| | F | 65.80 | 53–71 | 5.47 | 10 |
| | J | 71.29 | 61–78 | 4.12 | 17 |
| Occiput to dorsal fin origin | M | 131.38 | 117–147 | 9.09 | 13 |
| | F | 138.82 | 113–140 | 10.30 | 10 |
| | J | 128.70 | 115–138 | 7.53 | 19 |
| Snout length | M | 90.77 | 80–98 | 5.10 | 13 |
| | F | 86.36 | 80–91 | 3.88 | 11 |
| | J | 82.26 | 72–93 | 5.99 | 19 |
| Trans pelvic width | M | 87.31 | 77–104 | 7.67 | 13 |
| | F | 84.82 | 80–93 | 4.77 | 11 |
| | J | 82.63 | 74–91 | 4.56 | 19 |

TABLE 8. (Continued)

| Characters | | $\bar{x}$ | W | $S_x$ | N |
|---|---|---|---|---|---|
| Maximum body depth | M | 209.17 | 183–240 | 14.67 | 12 |
| | F | 208.00 | 186–233 | 14.95 | 11 |
| | J | 186.47 | 167–204 | 9.42 | 19 |
| Caudal peduncle length | M | 156.30 | 144–171 | 8.18 | 13 |
| | F | 162.18 | 140–174 | 11.19 | 11 |
| | J | 169.16 | 154–186 | 11.19 | 19 |
| Spinous dorsal fin length | M | 269.31 | 236–291 | 15.17 | 13 |
| | F | 257.00 | 224–277 | 15.51 | 11 |
| | J | 254.53 | 232–275 | 12.01 | 19 |
| Soft dorsal fin length | M | 295.93 | 254–349 | 28.93 | 13 |
| | F | 279.91 | 252–326 | 20.63 | 11 |
| | J | 287.32 | 246–306 | 12.94 | 19 |
| Anal fin length | M | 343.23 | 282–414 | 37.32 | 13 |
| | F | 248.09 | 228–264 | 10.89 | 11 |
| | J | 266.11 | 238–244 | 18.08 | 19 |
| Longest anal ray | M | 179.92 | 134–244 | 35.09 | 13 |
| | F | 134.80 | 116–151 | 11.75 | 10 |
| | J | 128.21 | 113–140 | 7.93 | 19 |
| Occiput to soft dorsal fin origin | M | 412.69 | 366–443 | 20.98 | 13 |
| | F | 418.00 | 398–442 | 16.16 | 11 |
| | J | 406.53 | 391–423 | 7.08 | 19 |
| Occiput to first saddle | M | 124.20 | 108–137 | 10.34 | 10 |
| | F | 127.50 | 113–147 | 9.58 | 10 |
| | J | 122.37 | 99–140 | 11.24 | 19 |
| Occiput to second saddle | M | 369.92 | 346–386 | 12.80 | 13 |
| | F | 365.72 | 339–389 | 13.50 | 11 |
| | J | 360.32 | 333–379 | 11.59 | 19 |
| Occiput to third saddle | M | 557.38 | 523–574 | 17.60 | 13 |
| | F | 558.91 | 532–585 | 14.05 | 11 |
| | J | 543.16 | 513–564 | 12.94 | 19 |
| Occiput to fourth saddle | M | 702.77 | 650–721 | 21.13 | 13 |
| | F | 704.45 | 665–726 | 16.42 | 11 |
| | J | 690.84 | 662–710 | 12.56 | 19 |
| Standard length | M | 57.3 | 49.7–65.3 | 4.38 | 13 |
| | F | 54.8 | 50.2–63.8 | 4.25 | 11 |
| | J | 44.0 | 38.2–49.3 | 2.31 | 19 |

*Additional specimens examined but not designated as types*: Two specimens collected at the type-locality, 23 April 1975, have been given to the Tennessee Wildlife Resources Agency, Nashville, Tenn. Two additional specimens, currently in the possession of the Tennessee Valley Authority, Norris, Tenn., were briefly examined and included in the counts in Tables 2–7, as follows: Type-locality, 1 specimen, 10 Nov. 1974; and Little Tennessee River at River Mile 4, Greene Farm, Loudon County, Tenn., 6 Jan. 1975.

*Comparative material of other species*: *Percina uranidea* (Jordan and Gilbert): Arkansas: Saline River system: NLU 16831 (49 of 205, less 1 specimen reidentified as *P. ouachitae* (Jordan and Gilbert), Saline River approximately 10 km south of Johnsville, Bradley-Ashley County line, 30 July 1970; NLU 14582 (60), Saline River at end of Ark. Highway 172, Drew Co., 6 Nov. 1969; NLU 14624 (16), Saline River at Vince Bluff, west of Herbine, Cleveland Co., 18 Nov. 1969; HWR 72-23 (1), Saline River 5 km east of Poyen at U.S. Highway 270 bridge, Grant Co., 10 June 1972; HWR 71-19 (2), Saline River 12 km north of Johnsville, Bradley Co., 12 Oct. 1971; HWR 74-108 (2), Saline River southeast of Johnsville, R. 8 W., T. 15 S., S. 31, Ashley Co., 26 Oct. 1974. Arkansas: White River system: TU 66011 (10 of 46), Current River 7 km northwest of Success along Ark. Highway 211, Randolph and Clay counties, 9 Oct. 1970; TU 66806 (30), same locality as TU 66011, 21 Nov. 1970; TU 92950 (25), Strawberry River at Ark. Highway 115 bridge, 1.6 km northeast of Jessup, Lawrence Co., 28 Sept. 1974; NLU 13874 (37), White River below Lock and Dam No. 1, Batesville, Independence Co., 14 July 1969. Indiana: Wabash River system: USNM 40922 (4), Wabash River at Vincennes, Knox Co., 1888; USNM 66971 (3), same locality, 15 Sept. 1888; USNM 125337 (1), same locality, 1888; USNM 40942 (1), Wabash River at New Harmony, Posey Co., 1888.

*Diagnosis*: The affinities of this species are within *Imostoma* and with the saddle-backed members of the subgenus. Differing from *P. ouachitae* in having the posterior margin of the fourth saddle positioned on the anterior dorsal insertion of the caudal fin (this saddle completely anterior to the anterior dorsal insertion of the caudal fin in *P. ouachitae*). Differing from the Conasauga River form in having the anteriormost dorsal saddle positioned under the anterior three to five dorsal spines (this saddle entirely anterior to the dorsal fin in the Conasauga River form). Most closely related to *P. uranidea*, but differing from that species in having shorter paired fins (Tables 1 and 3); a more robust body (see Table 1: interorbital width, width below origin of soft dorsal fin, and width below origin of third saddle). Dorsal saddles of *P. tanasi* are wider than those of *P. uranidea* from the Saline and Wabash river systems, and much wider than those of *P. uranidea* from the White River system (Table 1.). *P. tanasi* has a modal value of 12 soft anal fin rays (11 for *P. uranidea*) and 16 caudal rays (16 or 17 for *P. uranidea*) (Table 6). Background coloration of dorsum in live speci-

FIG. 1. *Percina tanasi*, UT 91.1074 (paratypes), Little Tennessee River at Coytee Spring, River Mile 7, Loudon County, Tennessee, 23 April 1975. Top, male, 61 mm SL; middle, female, 66 mm SL; bottom, dorsal view of male, 58 mm SL.

mens brownish gray with traces of green (russet brown in *P. uranidea*, Thompson, in lit.). Nuptial males with cheek entirely black to mostly black, the posterior one-third brown with occasional gold flecks (bright metallic gold in *P. uranidea*, Thompson, in lit.). Exposed ctenoid scales entirely absent from lateral areas of breast, or rarely with one or two ctenoid scales in these areas (nuptial males in *P. uranidea* with exposed ctenoid scales usually present on lateral areas of breast, these often forming a transverse band across the middle of the breast). Nuptial males with pelvic fin tubercles confined to the median four rays (pelvic fin tubercles on pelvic spine and adjacent four rays in *P. uranidea*).

*Description*: *Percina tanasi* (Fig. 1) is the most robust of the saddle-backed members of the subgenus *Imostoma*. The largest specimen is

a female, UT 91.1074, 66.5 mm SL. Two additional females and one male from this series, taken 23 April 1975, are over 60 mm SL. Minimum fleshy interorbital width (Table 1) greater than in *P. uranidea*, and much greater than for *P. ouachitae* or *P.* (*Imostoma*) sp. Body width (nearly 170 thousandths of SL) much greater than that of *P. ouachitae* or *P.* (*Imostoma*) sp.—both about 140 or less; the caudal peduncle tapers less rapidly than in *P. uranidea* (see width below origin of soft dorsal fin and width below origin of saddle 3, Table 1). It is so robust that the first specimen, seen underwater, was mistaken for a sculpin. Measurements of these and additional characters, expressed as thousandths of standard length, appear in Tables 1 and 8.

Lateral-line scales usually 49–56 (extremes 48–57), with 1 (0–2) pored scales posterior to hypural plate. Transverse scale rows, counted obliquely forward from first anal spine, 16–17 (15–19). Minimum caudal peduncle scale rows 20 (19–22). Frequency distributions for scale counts appear in Tables 2 and 4.

Dorsal spines X–XI (IX–XII); dorsal soft rays 14–16 (13–17). Anal spines 2; anal soft rays modally 12, often 11 (10–13). Principal caudal rays 16 (15–17). Pectoral rays modally 14, often 13, occasionally 15. Frequency distributions of fin ray counts appear in Tables 5–7.

Opercles and nape covered with exposed ctenoid scales. Cheek and breast squamation variable. Cheeks typically with embedded cycloid scales posterior to eye. In juveniles and subadults cheeks often appear naked. In adults embedded cycloid scales often more extensive on lower half of cheek; the entire cheek occasionally scaled. One adult male (USNM 214697) has about five exposed ctenoid scales on each cheek. Breast squamation variable dependent on age and apparently on sexual condition. In juveniles breast and prepectoral areas usually naked, or nearly so, with a few embedded scales in prepectoral region and/or on breast proper medial to pectoral fin base. Adults typically with embedded scales in these areas, and rarely with a transverse band of scales extending across breast between pectoral bases, as typical of *P. uranidea.* These scales occasionally ctenoid, often bearing low, rounded tubercles in nuptial males. Belly naked lateral to midventral row of modified scales.

Gill membranes weakly connected, occasionally separate. Branchiostegal rays 6-6, an occasional specimen with 7 rays on either side. Frenum varying from moderately developed to absent. Infraorbital canal complete, typically 8 pores per side. Preoperculomandibular canal with 10 pores per side. Supratemporal canal complete; supraorbital canal complete with 3 pores per side; coronal pore single.

Vertebral counts, 9 specimens, 39 (3), 40 (5), 41 (1), suggesting modal value of 40. Modal value for other saddle-backed *Imostoma* 39 (Thompson, in lit.).

Dorsum background color in life brown to brownish gray with traces of green, this pigmentation continuing ventrally to or nearly to lateral line. Dorsum crossed by four conspicuous chocolate-brown saddles. Anterior margin of saddle one at, or slightly anterior or posterior to base

of first dorsal spine. Posterior margin of this saddle between bases of third to fifth dorsal spines. Saddle two under posterior end of spinous dorsal fin, extending from base of last dorsal spine to or slightly behind base of first dorsal soft ray. Anterior margin of saddle three between bases of ninth to eleventh dorsal soft rays; it extends posteriad to base of thirteenth to fourteenth soft ray. Saddle four on caudal peduncle, with its posterior margin in contact with the unpigmented middorsal line extending forward from caudal fin. This unpigmented line represents the dorsal connective tissue insertion of caudal fin. Distances of saddles from occiput appear in Table 8. All saddles narrowest on midline, extending down and forward to lateral line. Saddle one occasionally inconspicuous in both living and preserved specimens. Ventral extensions of dorsal saddles interrupted at lateral line, but otherwise continuous with series of similarly colored lateral blotches extending about one-half scale row above, and three to four scale rows below lateral line. Paler areas below lateral line, alternating with dark lateral blotches, mottled pale green to greenish yellow in life, mottled in preservative. Belly typically immaculate, or with cluster of dark chromatophores in vicinity of anus. Lower sides adjacent to anal fin and ventral portion of caudal peduncle vary from virtually immaculate to darkly mottled with continuation of midlateral pigmentation. Breast pigmentation in juveniles and subadults varies from immaculate to sparsely freckled with dark chromatophores, especially at base of pelvic spine, in prepectoral area, and near depression in middle of breast. In adults dark chromatophores typically abundant at bases of pelvic spines and often between pelvic bases; an immaculate to weakly pigmented area immediately anterior to pelvic bases; anterior portion of breast moderately to completely freckled with dark chromatophores.

Head dark olive brown dorsally. Opercles and cheeks mottled brown and yellow. In life, iris orange-yellow adjacent to pupil, becoming brownish toward periphery. A black suborbital bar, wider than pupil, extends down and slightly posteriad from eye, terminating over interoperculum. In nuptial specimens, suborbital bar expands posteriad and occupies virtually entire cheek. Anterior portion of interoperculum and rami of lower jaw irridescent pale blue in life. Ventral surface of head with scattered groups of dark chromatophores in juveniles, and liberally freckled with dark chromatophores in adults.

Dorsal fin membranes lack bright colors. In spinous dorsal fin, dark chromatophores concentrated on margin of membrane posterior to tip of each spine, forming obscure marginal dark band. Additional dark chromatophore concentrations at or near base of each membrane, more concentrated on posterior half of each membrane, and restricted to basal one-third of membrane. Membrane of spinous dorsal fin clear elsewhere. Dorsal spines pale yellow with dark chromatophores concentrated near tip and middle of each spine. Dorsal soft rays pale yellow with four to five dark marks alternating with somewhat longer clear portions of each ray. Caudal fin pigmentation similar to that of

soft dorsal fin. Anal and pelvic fin pigmentation similar to that of soft dorsal fin, but dark chromatophores and pale yellow pigment on spines and rays less evident in adult males. In nuptial males these fins may be virtually immaculate. In nuptial females both anal and pelvic rays bright yellow-orange. Pectoral fins of both sexes have a yellow orange base, clear membranes, and pale yellow to orange-yellow rays, each of which marked with about five dark chromatophore concentrations. Concentrations of dark chromatophores on spines and rays of all fins neither sufficiently discrete nor aligned to form distinct bands.

*Sexual dimorphism*: As is typical of the subgenus *Imostoma*, the anal fin is much longer in adult males than in adult females. This character permits easy sex recognition. Anal fin length in specimens larger than 50 mm SL readily separates sexes in *P. tanasi*. Sex of *P. uranidea* specimens was easily determined in specimens of about 40 mm SL. Two male *P. uranidea* from the Saline River, HWR 74-108, collected 26 Oct. 1974, were tuberculate at 35.3 and 37.3 mm SL. Examination of the data in Tables 1 and 8 indicates that males differ from females in the following additional characters: longer snout, more slender body (probably attributable to gonad size), shorter caudal peduncle, greater length of all fins (see also Table 3), longer first anal spine, dorsal fins positioned closer to occiput, and possibly a narrower fourth saddle. *P. uranidea* exhibits similar dimorphism in these characters. *P. ouachitae* and *P.* (*Imostoma*) sp. are not measurably dimorphic in snout length, caudal peduncle length, caudal fin length, paired fin length (possibly slightly longer in male *P.* (*Imostoma*) sp.), spinous dorsal fin length, anal spine length, position of dorsal fin relative to occiput, or width of the fourth saddle.

Tubercles are conspicuous on males from early November through late April. In males with maximum development, uniserial tubercles are present on anal rays, on lower surface of the medial four pelvic rays, and on the principal caudal rays (plus two adjacent procurrent rays) on the lower half of the caudal fin. Tubercles are not present on either the pelvic or anal spines, but are present on one or both of these areas in other *Imostoma*. Although it is possible that examination of additional tuberculate specimens of *P. tanasi* might reveal the presence of tubercles on these spines, it seems rather unlikely, since the six nuptial males from UT 91.1074, collected 23 April 1975, are as tuberculate as any *Imostoma* I have examined. In several of these specimens the pelvic spines are very fleshy, but neither tubercles nor tubercle scars are present on the pelvic spine or on the adjacent pelvic ray. Tubercles are well developed on the remaining four pelvic rays. The tubercles on the anal fin had begun to slough off on these specimens, and might have already been lost from the anal spines. Branchiostegal rays have small, pointed tubercles. Single, low, rounded tubercles are present on scales on the cheek and breast, on three to four scale rows adjacent to the naked midventral area, on the modified midventral scales, on scales adjacent to the base of the anal fin, and on scales on the lower

Fig. 2. Photograph of the type-locality, Little Tennessee River at Coytee Spring, River Mile 7, Loudon County, Tennessee, as seen during minimum flow looking downstream from the gravel island which is slightly upstream from the spring outflow.

caudal peduncle and lower caudal fin base. Similar tubercles that are not borne by scales occur on the cheeks and breast, and over the interoperculum, rami of the lower jaw, and lachrymal (anterior infraorbital). Cteni on scales along the anal fin base are elongate in tuberculate males.

The female urogenital papilla is nearly cylindrical, about twice the diameter of the base of the first anal spine. Its anterior and lateral surfaces have about six deep longitudinal creases, and its posterior surface is in contact with the first anal spine. In males the urogenital papilla is a small, laterally expanded flap, also in contact with the base of the first anal spine and bearing longitudinal creases. Urogenital papillae are similar in other species in the subgenus.

*Etymology*: Tanasi (tan-ah'-see) was the Cherokee name for a village at River Mile 26 on the south bank of the Little Tennessee River, Monroe County, Tennessee. According to Duane King, Assistant Professor, Department of Sociology and Anthropology, University of Tennessee at Chattanooga, Tanasi served as the capital for the Cherokee Nation until 1725. The altered spelling (Tennessee) was first used by Lt. Henry Timberlake in 1762 (Williams, 1927).

*Biology*: *Percina tanasi* is restricted to gravel shoal areas in approximately the lower 32 km of the Little Tennessee River. Seining and underwater observation in this area indicate that fishes are not abundant. A crew of five persons, utilizing a small mesh 12-ft-long by 6-ft-deep seine, would be fortunate to collect as many as 50 fish per hour

in these gravel shoal areas. At the type-locality (Coytee Spring, River Mile 7) the Little Tennessee River is about 200 m wide. At low flow a small gravel island is visible near the north bank of the river, just upstream from the spring outflow (Fig. 2). The substrate is virtually all coarse gravel interspersed with sand, with areas of silt deposition along the banks, a few bedrock outcrops, and concentrations of boulders. Even during periods of minimum flow, current is swift over the gravel areas, and depths are uniformly about 1 m. *P. tanasi* is most often found in the swiftest current, but we have encountered specimens in moderate current. According to W. C. Starnes, who continues the life history study of the species, it typically avoids areas with abundant vegetation attached to the rocks and areas where manganese deposits have blackened the rocks. Our samples indicate that *P. tanasi* is the most abundant of the gravel shoal species at the type-locality. Species collected with *P. tanasi*: *Hybopsis aestivalis* (Girard), *Nocomis micropogon* (Cope), *Phenacobius uranops* Cope, *Hypentelium nigricans* (Lesueur), *Etheostoma blennioides* Rafinesque, *Etheostoma rufilineatum* (Cope), *Percina caprodes* (Rafinesque), *Percina evides* (Jordan and Brayton), *Cottus bairdi* Girard, and *Cottus carolinae* (Gill). *Etheostoma simoterum* (Cope), *Percina shumardi* (Girard), and species of *Notropis* and *Moxostoma* inhabit the more sluggish areas near the bank.

In spite of the abundance of aquatic insects, the major dietary component of *P. tanasi* appears to be small gastropods. *Anculosa, Ferrisia, Physa, Pleurocera,* and *Viviparous* are genera tentatively identified from stomach contents. Trichoptera (mostly *Brachycentrus etowahensis* Wallace) and occasional *Ephemeroptera* are found in stomachs of specimens taken in the spring; simuliid dipteran larvae are abundant in stomachs of specimens taken in mid-summer.

Specimens taken in early November included tuberculate males. Specimens from 23 April 1975 were apparently still involved in spawning activity (sexes were segregated, one female released several mature eggs when handled, males were still tuberculate), but most specimens were spent. Water temperature on this date was 14 C (57 F). Preliminary data indicates that sexual maturity is often reached between the second and third year, and that the life span is about four years.

*Phylogeny*: Because of their similarity in pigmentation, meristics, morphometry, and sexual dimorphism, *P. tanasi* and *P. uranidea* are considered to be closely related species, almost certainly derived from a common ancestor. This ancestral species was presumably widespread in swift streams and rivers with clear water and firm substrates in what is now the central and lower Mississippi River drainage. These populations have disappeared (as apparently has the Wabash River population of *P. uranidea*), presumably in response to silt and loess accumulation and lowered stream gradients. The present relict distribution, higher fin ray counts, and large maximum size of *P. tanasi* and *P. uranidea* suggest that these species are modified representatives of this ancestral species. I interpret *P. ouachitae* as a more recently evolved, generalized

form that has invaded areas formerly occupied by the common ancestor of *P. uranidea* and *P. tanasi*, perhaps from a population originally evolved in response to conditions in the Gulf Coastal or extreme lower Mississippi River drainages. Since *P. ouachitae* continues to occur in the main channel of the Mississippi River in west Tennessee, dispersal through the lowlands of the central portion of the Mississippi River drainage would have been easy once suitable habitats were available. Alternate interpretations, considering *P. ouachitae* as the ancestral form that has given rise to other saddle-backed *Imostoma*, appear less likely. I interpret *P.* (*Imostoma*) sp. as an early isolate in the upper Coosa River system, probably derived from the hypothetical ancestor of *P. tanasi* and *P. uranidea*, but not closely related to any existing *Imostoma*.

*Taxonomic status*: The population of saddle-backed *Imostoma* in the Little Tennessee River differs from known populations of *P. uranidea* in body width, paired fin length, saddle width, nuptial tubercle pattern, several aspects of pigmentation, number of anal and caudal fin rays, and probably vertebral number. I assume that genetic differences are responsible for most, if not all of this divergence. That this divergence is sufficiently large to justify recognition of the Little Tennessee River population as a distinct species is suggested by several sources of information besides the characters listed above. A useful clue to the probable taxonomic status of allopatric populations involves comparing the amount of divergence between such isolates with that between similar sympatric species in the same group. *P. uranidea* and *P. ouachitae* are sympatric in both the White and Saline river systems. The observable differences between these sympatric species (not recognized by modern ichthyologists as being distinct until 1970) are similar in magnitude to those between *P. uranidea* and *P. tanasi*. This indicates that striking differences are not prerequisite to maintenance of genetic isolation between sympatric *Imostoma*. Since the Wabash River population of *P. uranidea* does not display character states intermediate between those of Ozarkian populations and *P. tanasi* (Tables 1, 3, and 6), clinal differences are not involved.

*Conservation*: The entire range of *P. tanasi* would be innundated by impoundment of Tellico Reservoir, now under construction by the Tennessee Valley Authority. Although adults might persist in this reservoir for a year or two, reproduction following impoundment would no longer be possible and the species would become extinct within a few years. The possibility of finding additional populations of *P. tanasi* outside the area to be impounded appear to be extremely remote, since the remaining river and large stream habitat in this region has been well collected. *P. tanasi* is not a difficult species of darter to collect using standard seining techniques. We have not failed to collect specimens at the type-locality during periods of low flow.

*Percina tanasi*, the snail darter, is an endangered species in the strictest sense. It was proposed for "endangered species status" in the U.S. Federal Register, Vol. 40, No. 117, p. 25597–98, 17 June 1975, and

finally listed as such in the same volume, No. 197, p. 17505–06, 9 Oct. 1975.

Acknowledgments

Comparative material was provided by R. D. Suttkus, Tulane University; Neil H. Douglas, Northeastern Louisiana State University; and H. W. Robison, Southern State University, Magnolia, Ark. Specimens of *P. uranidea* from the extinct Wabash River population, housed at the U.S. National Museum, were on loan to Tulane University during this study. They were made available for my examination by Dr. Suttkus. Bruce A. Thompson, Tulane University, was extremely helpful in providing data on *P. uranidea*, vertebral counts, comments on the manuscript, and views on the subgenus *Imostoma*. Page costs were generously provided by the Tennessee Wildlife Resources Agency. The photograph of the type-locality was provided by Sam A. Venable, Jr., of the Knoxville News-Sentinel staff. Wayne C. Starnes gave valuable life history information and commented on the manuscript. I continue to be indebted to my enthusiastic students, who were eager to provide collecting assistance.

Literature Cited

Hubbs, C. L., and K. F. Lagler. 1958. Fishes of the Great Lakes region Cranbrook Inst. Sci. Bull. 26, Rev. ed, 213 p.

Page, L. M. 1974 The subgenera of *Percina* (Percidae: Etheostomatinae). Copeia 1974(1):66–86.

Taylor, W. R. 1969. A revision of the catfish genus *Noturus* Rafinesque, with an analysis of higher groups in the Ictaluridae. U.S. National Museum Bull. 282, 315 p.

Williams, S. C. 1927. Memoirs of Lt. Henry Timberlake 1756–1765. Watauga Press, Johnson City, Tenn., 197 p.

QH
1
B4X
NH

8, No. 45, pp. 489–496 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# REDESCRIPTION AND ASSIGNMENT TO THE NEW GENUS *LIRCEOLUS* OF THE TEXAS TROGLOBITIC WATER SLATER, *ASELLUS SMITHII* (ULRICH) (CRUSTACEA: ISOPODA: ASELLIDAE)

By Thomas E. Bowman and Glenn Longley
*Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560, and Biology Department, Southwest Texas State University, San Marcos, Texas 78666*

In September, 1899, Dr. C. H. Eigenmann of Indiana University visited San Marcos, Texas, for 3 days in an attempt to obtain living specimens of the cave salamander, *Eurycea rathbuni* (Stejneger) from the artesian well of the U.S. Fish Commission. No salamanders emerged from the well during Eigenmann's visit, but he collected a number of subterranean mollusks and arthropods, including "the front half of a new species of *Caesidotea* [sic!]" (Eigenmann, 1900). In his list of species, Eigenmann (1900) referred to this isopod as "*Caecidotaea smithii* n. sp.", a nomen nudem, since no other information was given. Two years later Ulrich (1902) published descriptions of the new species of crustaceans listed by Eigenmann, including *Caecidotea smithii*. Since no additional specimens of this isopod had been obtained, the description of *C. smithii* was based on Eigenmann's incomplete specimen, which lacked the telson and uropods as well as the ends of the 2nd antennae.

Until now Ulrich's brief description and crude illustrations have been the only primary account of *C. smithii*. Other references to this species, given in the synonymy below, are based on Ulrich's account and add nothing new. No additional specimens have been reported on, as far as we know.

Beginning in December 1973, one of us (Longley) has been sampling the San Marcos artesian well regularly by means of

nets attached to the outlet of the pipe. The numerous specimens of *Caecidotea smithii* obtained have enabled us to redescribe and illustrate it in detail. Because of its unsuspected distinctive features, we have found it necessary to propose a new genus for this interesting troglobitic isopod. A representative series of specimens has been deposited in the National Museum of Natural History, Smithsonian Institution.

**Lirceolus** new genus

*Diagnosis*: Small, blind, unpigmented. Head without lateral incisions. Mandibular palp well developed. Maxilla 1 outer lobe with apical spines (10) inserted on distomedial shoulder, separated by wide gap from much longer circumplumose seta at distolateral corner and naked seta near distal end of posterior surface; inner lobe with 8 plumose apical setae. Maxilliped with slender palp segments having sparse setation. Pereopods 1 and 4 similar in ♂ and ♀. ♂ pleopod 2 with small basal spur; labial spur and catch lobe absent. Pleopod 2 exopod with oblique suture as in *Lirceus*. Pleopods 4 and 5, exopod and endopod fused into single fleshy ramus.

*Type-species*: *Caecidotea smithii* Ulrich.

*Etymology*: *Lirceus*, a spring in Greece (according to Rafinesque, 1820), + the Latin diminutive suffix "-olus", referring to the resemblance to *Lirceus* and the small size of the new genus. Gender masculine.

*Lirceolus smithii* (Ulrich)
Figures 1–26

*Caecidotaea smithii* Eigenmann, 1900: 302 [nomen nudem].

*Caecidotea smithii* Ulrich, 1902: 93, pl. 16, figs. 10–18 [fig. 14 missing].—Banta, 1907: 77.—Chappuis, 1927: 61.—Van Name, 1936: 472–473, fig. 297.—Jeannel, 1943: 261.—Nicholas, 1960: 132.

*Caecidotea smithsii* Ulrich.—Richardson, 1905: 438–439, fig. 496. [lapsus].—Creaser, 1931: 6.—Miller, 1933: 103.

*Conasellus smithii* (Ulrich).—Birstein, 1951: 53.—Henry and Magniez, 1970: 356 [in list].—Mitchell and Reddell, 1971: 55.

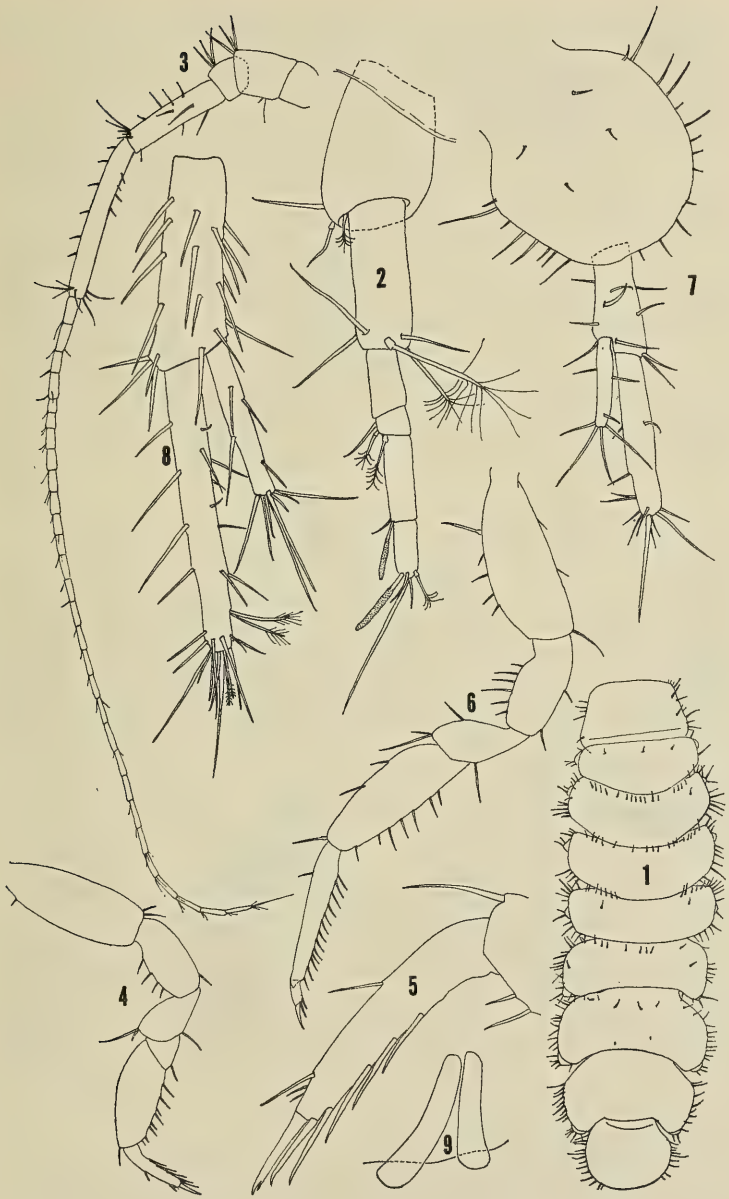
*Asellus smithii* (Ulrich).—Chace, Mackin, Hubricht, Banner, and Hobbs, 1959: 875.—Reddell, 1965: 158; 1970: 396.—Reddell and Mitchell, 1969: 8. Steeves, 1968: 183.—Fleming, 1973: 294 [in list].

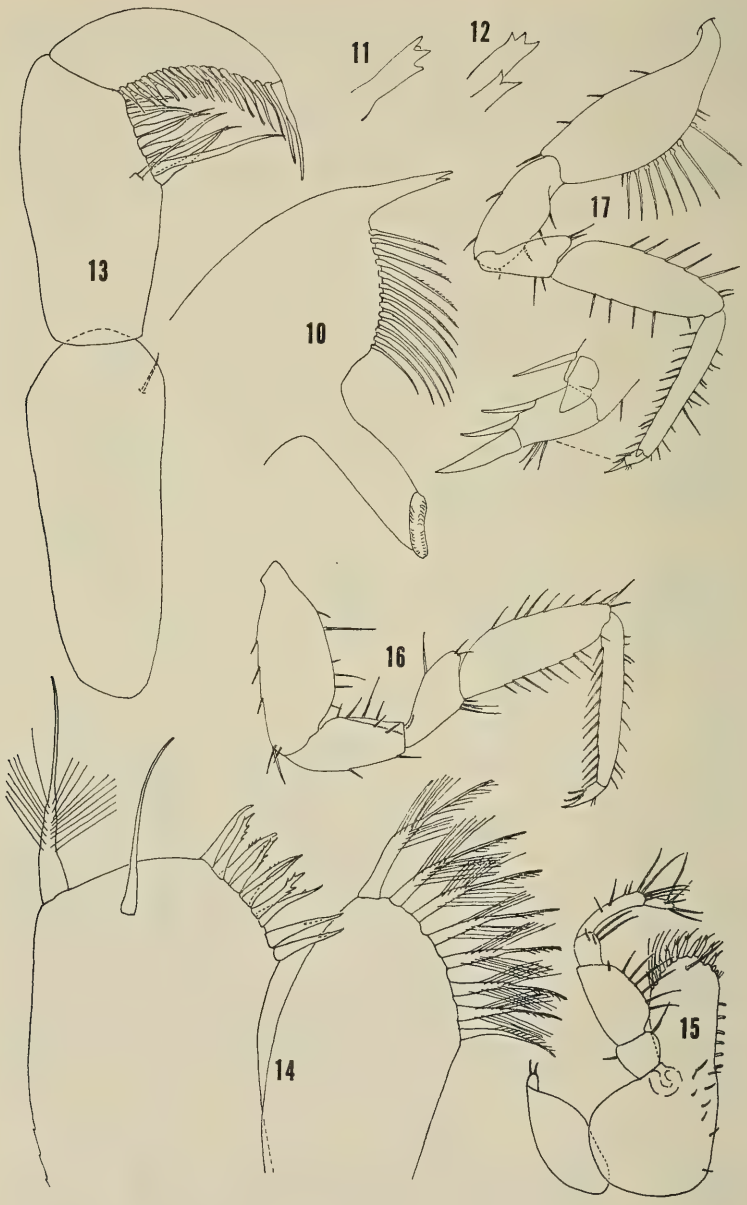
[non] *Asellus smithii* (Ulrich)?—Dearolf, 1953: 227 [vide Reddell, 1970].

---

→

Figs. 1–9. *Lirceolus smithii*. 1, ♂ body, dorsal; 2, Antenna 1, 1.8 mm ♀, dorsal; 3, Antenna 2, 3.3 mm ♀, dorsal; 4, Left pereopod 1; 5, Dactyl of same; 6, Left pereopod 2; 7, Telson and uropod, dorsal, of 1.8 mm ♀; 8, Right uropod, dorsal, of 3.7 mm ♀; 9, Penes.


3
2
7
8
6
1
4
5
9


11
12
17
13
10
16
14
15

*Description*: Length up to at least 3.7 mm. Body slender, about 3½ times as long as wide; width increasing gradually posteriorly to pereonite 6, then decreasing. Coxae all visible in dorsal view. Margins of head, pereonites, and telson moderately setose. Head nearly twice as wide as long; anterior margin nearly straight, without rostrum; postmandibular lobes weakly developed. Telson unusually small, orbicular; width and length subequal; caudomedial lobe barely evident.

Antenna 1 slightly longer than head; flagellum of 2–4 segments, last 2 segments at each bearing esthete. Antenna 2 about as long as body; flagellum of about 30 segments.

Mandible with 3-cuspate incisors and 2-cuspate lacinia mobilis; spine row with 13 spines on each mandible; palp with unusually long 1st segment and compact spination on 3rd segment. Maxilla 1 and maxilliped as in generic diagnosis and illustrations.

Pereopod 1 propus not enlarged; palm without processes; flexor margin of dactyl with 5–6 long slender spines. Pereopods 2–7 similar; basis with distinctive bulbous-based setae on margin; carpus and propus with long slender spines on 1 or both margins; dactyl with 2 spines on flexor margin.

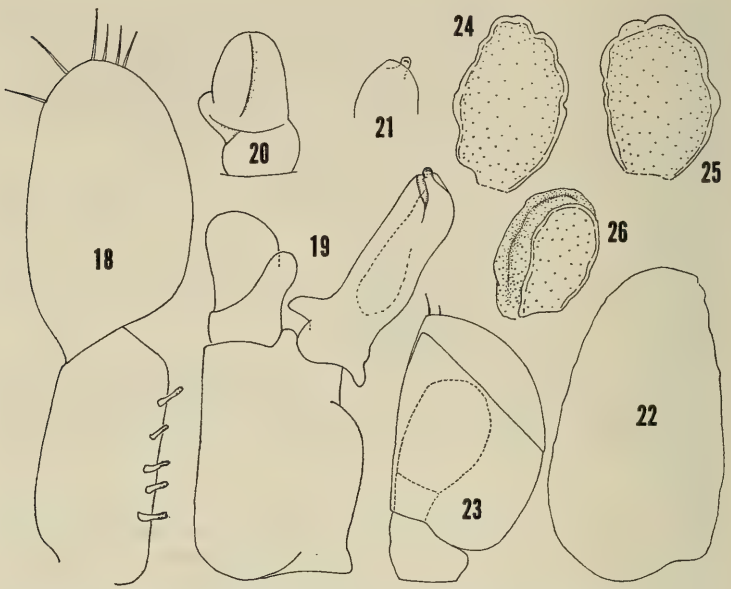
♂ pleopod 1 larger than pleopod 2; protopod slightly shorter than exopod, with 5 retinaculae; exopod oval, slightly less than twice as long as wide, with a few short naked setae on distal margin. ♂ pleopod 2 exopod, proximal segment produced distomedially over anterior surface of distal segment; distal segment with longitudinal furrow on posterior surface. Endopod slender, about 3.6 times as long as wide; margins parallel distal to short medial and lateral spurs at base; fissure oblique; medial process running obliquely laterad and ending in knob extending slightly beyond broadly rounded caudal process. ♀ pleopod 2 suboval, slightly more than half as wide as long; margins without setae. Pleopod 3 exopod with margins unarmed except for 2 setae at distomedial corner. Pleopods 4–5 uniramous; groove encircling margin indicates line of fusion of rami. Uropod with narrow linear rami bearing long setae; endopod about 1.8 times as long as exopod.

*Relationship*: The oblique suture on the exopod of pleopod 3 is a distinctive character which *Lirceolus* shares only with *Lirceus*, and suggests that *Lirceus* may be ancestral to *Lirceolus* or that the 2 genera share a common ancestor. The structure of maxilla 1 is unique; all known Asellidae have a maxilla 1 inner lobe with either 4 apical setae (*Asellus* (*Asellus*)) or 5 apical setae (all other Asellidae). The finding of 8 setae on *L. smithii* was so unexpected that the maxilla 1 of several speci-

---

←

Figs. 10–17. *Lirceolus smithii*. 10, Right mandible, gnathal margin; 11, Incisor of right mandible; 12, Incisor and lacinia of left mandible; 13, Mandibular palp; 14, Right maxilla 1; 15, Right maxilliped; 16, ♀ pereopod 4; 17, ♀ pereopod 6.




Figs. 18–26. *Lirceolus smithii*. 18, ♂ pleopod 1, anterior; 19, ♂ pleopod 2, anterior; 20, ♂ pleopod 2 exopod, posterior; 21, ♂ pleopod 2, endopod tip, posterior; 22, ♀ pleopod 2; 23, ♂ pleopod 3, anterior; 24, ♀ pleopod 4; 25, ♀ pleopod 5; 26, ♀ pleopod 5, tilted to show line of fusion between rami.

mens was examined in order to be sure that this number is constant. The position of the spines of the outer lobe of maxilla 1 is also unusual; in other Asellidae they are terminal rather than on an oblique subterminal shoulder.

The extreme reduction of pleopods 4 and 5 is known in no other Asellidae, but these pleopods have not been described in most species. The small size of *L. smithii*, together with the well known low metabolism of troglobites, suggests that this species requires minimal respiratory surface.

## Literature Cited

Banta, Arthur M. 1907. The fauna of Mayfield's Cave. Carnegie Inst. Washington Publ. No. 67:1–114.

Birstein, J. A. 1951. Freshwater isopods (Asellota). Fauna SSSR, Crustacea 7 (5):1–140 [in Russian; English translation by Israel Program for Scientific Translation, 148 pp. 1964].

Chace, Fenner A., Jr., J. G. Mackin, Leslie Hubricht, Albert H. Banner, and Horton H. Hobbs, Jr. 1959. Chap. 31, Malacostraca. Pp. 869–901 *in* W. T. Edmondson, ed., Fresh-water Biology, Second edition, New York, xx + 1248 pp.

Chappuis, P. A. 1927. Die Tierwelt der unterirdischen Gewässer. Die Binnengewässer 3:1–175.

Creaser, Edwin P. 1931. A new blind isopod of the genus *Caecidotea* from a Missouri cave. Occ. Pap. Mus. Zool. Univ. Michigan, No. 222:1–7, pls. 1–2.

Dearolf, Kenneth. 1953. The invertebrates of 75 caves in the United States. Proc. Pennsylvania Acad. Sci. 27:225–241.

Eigenmann, Carl H. 1900. A contribution to the fauna of the caves of Texas. Science 12:301–302.

Fleming, Laurence E. 1973. The evolution of the eastern North American isopods of the genus *Asellus* (Crustacea: Asellidae). Part II. Intern. Jour. Speleol. 5:283–310.

Henry, Jean-Paul, and Guy Magniez. 1970. Contribution à la systématique des Asellides (Crustacea Isopoda). Ann. Spéléol. 25(2):335–367.

Jeannel, R. G. 1943. Les fossiles vivant des cavernes. Gallimard, 321 pp.

Miller, Milton A. 1933. A new blind isopod, *Asellus californicus*, and a revision of the subterranean asellids. Univ. California Publ. Zool. 39(4):97–110.

Mitchell, Robert W., and James R. Reddell. 1971. The invertebrate fauna of Texas caves. Pp. 35–91 *in* Ernest L. Lundelius and Bob H. Slaughter, eds., Natural History of Texas Caves. Gulf Natural History, Dallas.

Nicholas, Bro. G. 1960. Checklist of macroscopic troglobitic organisms of the United States. Amer. Midl. Nat. 64(1):123–160.

Rafinesque, C. S. 1820. Annals of nature or annual synopsis of new genera and species of animals, plants, etc., discovered in North America by C. S. Rafinesque. First annual number for 1820. Thomas Smith, Lexington, Kentucky, 16 pp.

Reddell, James R. 1965. A checklist of the cave fauna of Texas. I. The Invertebrata (exclusive of Insecta). Texas Jour. Sci. 17 (2):143–187.

———. 1970. A checklist of the cave fauna of Texas. IV. Additional records of Invertebrata (exclusive of Insecta). Texas Jour. Sci. 21(4):389–415.

Reddell, James R., and Robert W. Mitchell. 1969. A checklist and annotated bibliography of the subterranean aquatic fauna of Texas. Texas Technological College, Water Resources Center, Spec. Rep. no. 24:1–48 (mimeographed).

Richardson, Harriet R. 1905. A monograph on the isopods of North America. Bull. U.S. Nat. Mus. 54:LIII + 727 pp.

Steeves, Harrison R. III. 1968. Three new species of troglobitic asellids from Texas. Amer. Midl. Nat. 79(1):183–188.

Ulrich, Carl J. 1902. A contribution to the subterranean fauna of Texas. Trans. Amer. Microsc. Soc. 23:83–101, pls. 14–18.

Van Name, Willard G. 1936. The American land and fresh-water isopod Crustacea. Bull. Amer. Mus. Nat. Hist. 71:1–535.

QH
1
B4X
NH

, No. 46, pp. 497–502 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# *SARSIELLA OZOTOTHRIX*, A NEW SPECIES OF MARINE OSTRACODA (MYODOCOPINA) FROM THE ATLANTIC AND GULF COASTS OF NORTH AMERICA

By Louis S. Kornicker and Marcia Bowen
*Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560, and*
*New York Ocean Science Laboratory*
*Montauk, New York 11954*

SMITHSONIAN
JAN 1 1976

Specimens of *Sarsiella ozotothrix*, the new species described below, were collected at three localities: 1, Stonewall Pond, Chilmark, Martha's Vineyard, Massachusetts; 2, Long Island Sound between Eatons's Neck, Long Island and Darien, Connecticut; and 3, Alligator Harbor, Florida. The species was not reported from the Sapelo Island area of Georgia by Darby (1965), nor is it present in extensive collections from the Fort Pierce area of Florida examined by the senior author. This might indicate that the Atlantic and Gulf coasts populations are disjunct. The known distribution suggests that the species may have inhabited the southeastern coast of North America in the past, possibly during colder climates of the Pleistocene. A similiar explanation was proposed for the disjunct Atlantic-Gulf coast distribution of *Sarsiella zostericola* Cushman 1906, by Kornicker (1975:130).

## SUBORDER MYODOCOPINA

Sarsiellidae Brady and Norman, 1896
*Sarseilla* Norman, 1869
**Sarsiella ozotothrix**, new species
Figures 1–3

*Etymology*: The specific name is from the Greek *ozotos* = branching, branched, combined with *thrix* = hair and refers to the branching hairs or bristles on the carapace.

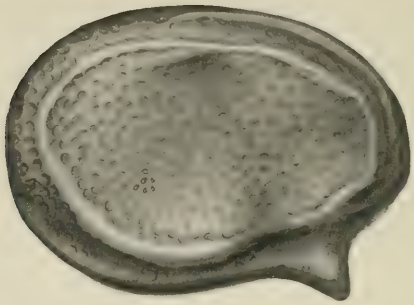


FIG. 1. *Sarsiella ozotothrix* new species, paratype, left lateral view of ovigerous female from Alligator Harbor, Florida, USNM 152441, length 0.95 mm.

*Material examined*:—Alligator Harbor, Florida, Sta. I, 5-2, depth and precise locality unknown; Darrell K. Jones, collector, exact date unknown, about 1957; 1 ovigerous ♀ paratype, USNM 152441.

—Long Island Sound, sta. EB8-2, dump site between Eaton's Neck, Long Island, and Darien, Connecticut, 41°00′N, 73°26′W, depth 23.5 m; sandy bottom, 93% sand, 3% silt, 4% clay; substrate and water surface temperature 3.0°C (substrate temperature taken aboard ship when grab was opened), Marcia Bowen collector, February 1975; 9 paratypes (returned to collector).

—Martha's Vineyard, Massachusetts, Stonewall Pond (between Gay Head and Chilmark) near ocean side, separated from ocean by bar; Mrs. C. R. Stoertz, collector, July 1965: Sta. 1, water depth 2 m (type-locality), 1 ovigerous ♀ holotype, USNM 152455 (in alcohol and on slides); 4 paratypes, USNM 152454. Sta. 6, water depth 3 m, 5 paratypes including 1 ovigerous ♀ and 1 adult ♀, USNM 152847, and 3 adult ♂, USNM 153929 and 153920.

*Distribution*: Martha's Vineyard, Massachusetts; Long Island Sound; Alligator Harbor, Florida.

*Description of Adult Female*: Carapace oval in lateral view with prominant caudal process and without rostrum or incisur (Figs. 1, 2a); carapace in posterior half widest dorsally, in anterior half widest ventrally.

Ornamentation: Continuous oval ridge composed of bristles present on each valve approximately parallel to outer margin of valve except in vicinity of caudal process (Figs. 1, 2a); anteroventral segment of ridge less convex than anteroventral margin of valve; a rib composed of bristles present just within dorsal margin of valve; surface of valve with small flat-bottomed fossae; radial ribs composed of bristles perpendicular to oval ridge present along anteroventral, ventral, and posteroventral margins.

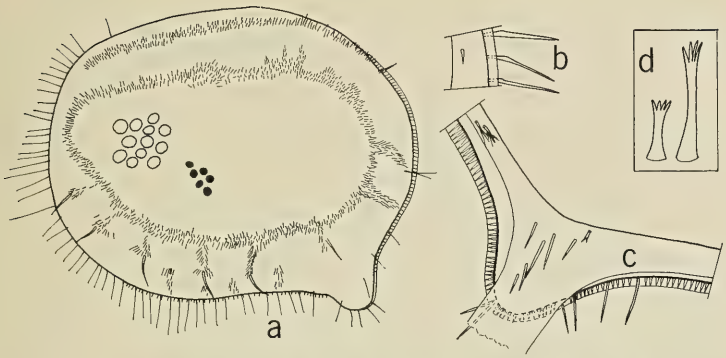



Fig. 2. *Sarsiella ozotothrix* new species, holotype, USNM 152455, ovigerous female from Martha's Vineyard, Massachusetts: a, Left lateral view of left valve, open circles represent fossae which completely cover surface, black dots represent central adductor muscle endings; b, Detail of anterior infold of left valve near middle showing minute bristle on infold and 3 marginal bristles, medial view; c, Caudal process of left valve and 2 flagellate posterior bristles, medial view; d, Sketch of short and long bristles with branching tips that are abundant on outer surfaces of valves.

Bristles: Long bristles with pointed tips and broad ringed bases present along anterior and ventral valve margins and scattered over valve surface (Fig. 2a–c); long stout bristles with branching tips form ridges and ribs on valves (Fig. 2d); shorter bristles with branching tips present on bottoms of fossae and between fossae (Fig. 2d); transparent organic substance present between bristles on most specimens.

Infold: Anterior infold with minute bristle near middle (Fig. 2b); infold in front of caudal processes with 4–6 bristles (Fig. 2c); 2 flagellate bristles present on posterior infold dorsal to caudal process (Fig. 2c); a few minute bristles present along inner margin of infold in vicinity of caudal process.

Selvage: Wide lamellar prolongation with smooth outer edge present along anterior, ventral, and posterior margins of both valves.

Size: USNM 152441, length 0.96 mm, height 0.72 mm with caudal process; USNM 152454-A, length 0.99 mm, height 0.84 mm with caudal process, 0.83 mm without; USNM 152454-C, length 1.05 mm, height 0.86 mm with caudal process; USNM 152455-A, length 1.05 mm, height 0.93 mm with caudal process; USNM 152455-B, length 1.00 mm, height 0.85 mm with caudal process; adult female from Long Island Sound, length 0.95 mm, height excluding caudal process 0.70 mm.

First antenna (Fig. 3a): 1st joint bare; 2nd joint with short bristle and long hairs on dorsal margin; 3rd joint with 2 short bristles, 1 ventral,

Fig. 3. *Sarsiella ozotothrix* new species, a–j, Paratype, USNM 152441: a, Right 1st antenna, medial view; b, c, Endopodites of right and left 2nd antennae, medial views; d, Right mandible, medial view; e, Right maxilla, lateral view; f, Tip of 5th limb; g, 6th limb; h, 7th limb; i, Anterior of body showing lateral eye, medial eye and rod-shaped organ, anterior triangular process, and upper lip at bottom of figure; j, Posterior of body showing right lamella of furca, right genitalia and brush-like organ, and right Y-sclerite; k, USNM 152454-A, 6th limb.

1 dorsal; 4th joint with very short dorsal bristle, 2 long ventral bristles, and spines and hairs on medial surface and along ventral and dorsal margins; sensory bristle of 5th joint with 2 minute filaments; 6th joint with short medial bristle. Seventh joint: a-bristle about twice length of bristle of 6th joint; b-bristle about 4 times length of a-bristle, bare;

c-bristle long with 2 minute filaments. Eighth joint: c- and d-bristles long, bare; e-bristle long, bare; f-bristle long with 3 minute filaments.

Second antenna: Protopodite bare; endopodite with 1 short bare proximal bristle and 1 longer spinous terminal bristle (Fig. 3b, c). Exopodite: 1st joint with long proximal hairs along ventral margin and small medial spine on distal margin; bristle of 2nd joint long, with short slender spines along middle of ventral margin and long natatory hairs along proximal dorsal margin and distal part of ventral margin; bristles of joints 2–8 with natatory hairs; 9th joint with 3 bristles, 2 long with natatory hairs, 1 short with short slender marginal spines; spines observed along distal margins of joints 2–4; few small medial spines forming short row on joint 2 proximal to row of spines along distal margin.

Mandible (Fig. 3d): Coxale endite consisting of stout spine; ventral margin of coxale with long hairs. Basale: dorsal margin with 1 minute subterminal spine; ventral margin with 5 minute spines: 3 proximal and 1 distal on medial surface; 1 proximal with base on lateral side. Endopodite: 1st joint with distal medial spines and minute terminal spine on dorsal margin (not seen with certainty); no spines observed at base of main claw; 2nd joint with subterminal spine on dorsal margin; no spines observed at base of main claw; 3rd joint with minute dorsal spine at base of main claw; no teeth observed on claws of endopodite. Exopodite absent.

Maxilla (Fig. 3e): Endite I with 4 bristles; endite II with 3 bristles; endite III with 7 bristles; coxale with 1 anterior bristle; basale with 1 short bristle near exopodite; exopodite with 2 bristles, 1 short, 1 long; 1st endopodite joint with spinous alpha- and beta-bristles, and a few short spines distally on anterior margin; 2nd endopodite joint with 2 lateral a-bristles, 1 medial c-bristle, and usual 5 pectinate terminal bristles.

Fifth limb: Epipodial appendage with 25–27 bristles; single endite with 1 short bristle. Exopodite (Fig. 3f): joints fused; 1st joint with 2 bristles; remaining joints with total of 5 bristles; surface of exopodite hirsute.

Sixth limb (Fig. 3g, k): Endite with 3 bristles, end joint with 11 bristles.

Seventh limb (Fig. 3h): Proximal group with 2 bristles, 1 on each side; distal group with 6 bristles, 3 on each side; each bristle with 2–5 bells; all bristles without marginal spines; terminus with opposing combs, each with about 6 or 7 opposing teeth.

Furca (Fig. 3j): Each lamella with 5 pointed claws; claw 1 separated from lamella by suture; claws 2–5 joined to lamella; claws 1–3 with few stout and many slender teeth along posterior margins; 2 minute spines and many long hairs on lamella following claw 5.

Eyes (Fig. 3i): Lateral eyes with 4–5 ommatidia; medial eye pigmented, about same size as lateral eye.

Rod-shaped organ (Fig. 3i): Elongate with proximal wrinkles and rounded tip.

Genitalia (Fig. 3j): Oval amber-colored process present on each side of body anterior to furca.

Brushlike organ (Fig. 3j): Consisting of 3 minute ringed bristles above genitalia.

Posterior of body: Bare.

Upper lip: Simple with rounded anterior process at tip. (Fig. 3i).

Y-sclerite: Typical for family (Fig. 3j).

Eggs: USNM 152441 with 6 eggs in marsupium, USNM 152454-A with 5 eggs.

*Comparisons*: The new species, *S. ozotothrix*, differs from other species of *Sarsiella* in having on each valve a continuous well-developed oval ridge formed of bristles with branching tips. The morphology of the endopodite of the 2nd antenna differs from many species of *Sarsiella* in having 1 proximal and 1 terminal bristle.

## Literature Cited

Darby, D. G. 1965. Ecology and taxonomy of Ostracoda in the vicinity of Sapelo Island, Georgia, pp. iii–vi, 1–76, text-figs. 1–89. Report No. 2 *in* Kesling, Darby, Smith, and Hall, Four Reports of Ostracod Investigations Conducted under National Science Foundation Project GB-26. University of Michigan, Ann Arbor.

Kornicker, L. S. 1975. Spread of ostracodes to exotic environs on transplanted oysters, pp. 129–139, text-figs. 1–3. *In* F. M. Swain, L. S. Kornicker, and R. F. Lundin (eds.), Biology and Paleobiology of Ostracoda. Bull. Amer. Paleontol. 65(282):1–687. Paleontological Research Institution, Ithaca.

QH
1
B4X
NH

No. 47, pp. 503–508 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# TWO NEW INDO-WEST PACIFIC CARDINALFISHES OF THE GENUS *APOGON*

By Thomas H. Fraser and John E. Randall
*Environmental Quality Laboratory,*
*Port Charlotte, Florida 33952 and*
*Bernice P. Bishop Museum, Honolulu, Hawaii 96818*

SMITHSONIAN

Recent deep-SCUBA collections of coral reef fishes in the Solomon, Palau and Cocos-Keeling Islands have yielded two closely related species of *Apogon.* These are described herein and their subgeneric relationships discussed.

All measurements were made with dial calipers. Gillrakers counts include all rudiments. The raker at the angle of the arch is included in the lower arch count. The last dorsal and anal rays are a composite of two elements divided to the base; they are counted as one. Radiographs have been examined for all specimens.

Type-material is deposited at the following museums: Academy of Natural Sciences, Philadelphia (ANSP); Australian Museum, Sydney (AMS); Bernice P. Bishop Museum, Honolulu (BPBM); California Academy of Sciences, San Francisco (CAS); Rijksmuseum van Natuurlijke Historie, Leiden (RMNH); National Museum of Natural History, Washington, D.C. (USNM).

The senior author gratefully acknowledges support from the South African Council for Scientific and Industrial Research, Rhodes University and the Smithsonian Institution. The junior author received support for field work from the National Science Foundation and the National Geographic Society. We thank James F. McKinney and Janet Gomon for taking radiographs of the specimens. E. A. Lachner and M. M. Smith are thanked for reading draft portions of the manuscript.

**Apogon dispar**, new species

Figure 1

*Diagnosis*: A species of *Apogon* with a narrow, red band from the tip of the snout to the base of the caudal fin, ending in a squarish red spot; two small red spots behind and slightly above the eye; and caudal fin lobes broadly tipped with red.

*Description*: For general shape and pigment pattern see Figure 1. Proportions for nine of the 14 specimens 37–48 mm SL (as percent of standard length with holotype in parentheses): body depth (32) 28–32; head length (37) 36–40; eye length (12) 11–12; snout length (10) 9–12; bony interorbital width (7) 7; upper jaw length (18) 17–18; caudal peduncle depth (10) 10–13; caudal peduncle length (28) 28–31; dorsal spine length—first (1) 1–2, second (11) 10–11, third (17) 15–17, fourth (15) 14–15, last (14) 13–14 (spine is in second dorsal); anal spine lengths—first (3) 2–3, second (14) 14–15; pectoral fin length (20) 20–21; pelvic fin length (18) 18–21.

Dorsal fin VII—I,9 except one with VII—I,8; anal fin II,8 except one II,9; pectoral fin (both sides counted) 13(11) or 14(5), frequencies in parentheses; pelvic fin I,5; principal caudal rays 9+8; secondary caudal rays 6–10 above and 7–10 below; well developed gillrakers 21–25 (4–5+17–20), including rudiments 23–26 (0–3+4–5; 17–20+0–1), the holotype 0+5–18+1; pored lateral line scales 25; transverse scale rows above lateral line 2; median predorsal scales 4 or 5; circumpeduncular scales 12–13 (5–2–5 or 6); other scale counts could not be taken because of lost scales.

Premaxilla with two rows of teeth anteriorly becoming a narrow band on the side; all teeth villiform with the outer teeth larger than those of the inner row. Dentary with two rows of teeth anteriorly becoming one row on the side, all villiform and about the same size; vomer with one row of three small teeth on each side; none to three teeth on the palatine, no teeth on ectopterygoid or endopterygoid, occasionally teeth on base of basihyal.

Vertebrae 10+14; basisphenoid present; supramaxilla absent; 2 predorsals; 2 dorsal spines on the first pterygiophore; 7 epipleural ribs; 5 free hypurals; 3 epurals; 1 pair of uroneurals; suspensory pharyngeal present; 4 upper pharyngeal tooth patches; 7 branchiostegal rays; no hidden eighth dorsal spine; posttemporal serrated; preopercular ridge smooth, ventral and posterior edges serrated; infraorbitals smooth; shelf on third infraorbital.

Swim bladder with a single rete bundle and gas gland; the presence of an oval could not be established.

*Coloration*: From an Ektachrome transparency taken soon after death: Most of body translucent with orange-red and white markings; an orange-red stripe extending from tip of lower jaw to anterior margin of eye, thense continuing as a narrow post-ocular stripe, ending at base of

FIG. 1. *Apogon dispar*, holotype, BPBM 9378, 44.1 mm SL, Palau Islands, photographed freshly fixed in formalin.

caudal fin in a squarish spot; a small white spot above this orange-red spot; two small reddish spots behind and slightly above eye; caudal fin lobes broadly tipped with red; cheek and abdomen silvery.

*Color in 55% isopropyl alcohol*: All fins pale and translucent; a faint dark band along midside becoming a diffuse basicaudal mark; scales above lateral stripe outlined with black chromatophores; a small patch of dark chromatophores on nape behind and slightly above eye; dusky stripe on snout to tip of lower jaw; peritoneum white with many small dark chromatophores; intestine white with few dark chromatophores, stomach becoming blackish with numerous chromatophores. Coloration of the Cocos-Keeling Island specimens similar in 70% ethyl alcohol, except lobes of caudal fin dusky.

*Distribution*: *Apogon dispar* is known from 14 specimens taken at the Palau and Solomon Islands in the Pacific Ocean and from Cocos-Keeling Islands in the Indian Ocean, at depths of 18–58 m.

*Holotype*: BPBM 9378 (44.1 mm SL), Palau Islands, Augulpelu Reef at southwest end, small cave at base of drop-off, depth 36 m, 13 April 1970, J. E. Randall.

*Paratypes*: BPBM 17017 (2 specimens, 44.3–44.8 mm), USNM 212134 (2, 45.8–48.2), USNM 212135 (1, 44.3, cleared and stained), CAS 30648 (1, 48.1), Solomon Islands, Florida Island, south side of Tanavula Point, 09°02′44″S, 160°04′07″E, vertical reef wall with caves, 18–37, 30 July 1973, Randall and G. R. Allen. ANSP 128364 (6, 21.7–38.1) Cocos-Keeling Islands, Turk Reef, vertical face, 51–58 m, 25 March 1974, W. F. Smith-Vaniz and P. Colin. ANSP 128365 (1, 38.6) Cocos-Keeling Islands, Turk Reef, drop-off reef face and cave, 45–49 m, 8 March 1974, Smith-Vaniz and Colin.

*Etymology*: The latin adjective *dispar*, meaning unlike or different, is used because of the unusual body shape and coloration of this *Apogon*.

TABLE 1. Frequency distributions of selected characters of *Apogon dispar* and *Apogon melanoproctus*.

| | Upper arch gillrakers | | | | Total gillrakers | | | | | Second dorsal spine in % of SL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 23 | 24 | 25 | 26 | 27 | 10 | 11 | 12 | 13 |
| *A. dispar* | 6* | 6 | 1 | – | 1 | 5* | 5 | 2 | – | 2 | 5* | – | – |
| *A. melanoproctus* | – | 2 | 9* | 1 | – | – | 2 | 8* | 2 | – | 5* | 5 | 1 |

| | Caudal peduncle length in % of SL | | | | | | Body depth in % of SL | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 27 | 28 | 29 | 30 | 31 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
| *A. dispar* | – | – | 2* | 4 | 1 | 2 | 2 | 2 | 3 | 1* | 1 | – | – |
| *A. melanoproctus* | 1 | 5* | 6 | – | – | – | – | – | – | 3 | 4* | 3 | – |

| | Upper jaw length in % of SL | | | | Pectoral fin in % of SL | | | |
|---|---|---|---|---|---|---|---|---|
| | 15 | 16 | 17 | 18 | 20 | 21 | 22 | 23 |
| *A. dispar* | – | 2 | 3 | 4* | 5* | 2 | – | – |
| *A. melanoproctus* | 6 | 6* | – | – | – | – | 7* | 5 |

* Includes holotype

**Apogon melanoproctus**, new species

Figure 2

*Diagnosis*: A species of *Apogon* with a faint brown-orange caudal base with a white spot above; a white spot just behind the base of the soft dorsal fin; and a black area around the anus.

*Description*: For general shape and pigment pattern see Fig. 2. Proportions for the 12 specimens (as percent of standard length with holotype in parentheses): body depth (32) 31–34; head length (39) 36–39; eye length (12) 12–13; snout length (10) 8–10; bony interorbital width (7) 7–8; upper jaw length (16) 15–16; caudal peduncle depth (13) 12–14; caudal peduncle length (27) 26–28; dorsal spine lengths—first (1) 1–3, second (11) 11–13, third (17) 15–18, fourth (16) 15–16, last (13) 13–15 (spine is in second dorsal); anal spine lengths—first (3) 2–3, second (15) 14–15; pectoral fin length (22) 22–23; pelvic fin length (21) 19–22.

Dorsal fin VII—I,9; anal fin II,8 except one with II,9; pectoral fin (both sides counted) 14 (11), 13 (1), frequencies given in parentheses; pelvic fin I,5; principal caudal rays 9+8; secondary caudal rays 8–9 above and 8–9 below; well-developed gillrakers 22–24 (4–5+18–19), including rudiments 25–27 (2–3+4–5; 18–19+0–1), holotype 2+5–19 +0; pored lateral line scales 24; longitudinal row above lateral line 24;

FIG. 2. *Apogon melanoproctus*, holotype, BPBM 15474, 40.0 mm SL, Solomon Islands, photographed freshly fixed in formalin.

transverse rows above lateral line 2; transverse rows below lateral line 6; median predorsal row 5; circumpeduncular scales 12 (5–2–5).

One row of teeth on dentary; two or three rows on premaxilla becoming one row on side; teeth on palatine few or absent; no teeth on vomer, ectopterygoid or endopterygoid; occasionally teeth on base of basihyal.

Vertebrae 10+14; basisphenoid present; supramaxilla absent; 2 predorsals; 2 dorsal spines on the first pterygiophore; 7 epipleural ribs; 5 free hypurals; 3 epurals; 1 pair of uroneurals; suspensory pharyngeal present; 4 upper pharyngeal tooth patches; 7 branchiostegal rays; no hidden eighth dorsal spine; posttemporal serrated; preopercular ridge smooth, ventral, and posterior edges serrated; infraorbitals smooth; shelf on third infraorbital.

Swim bladder with a single bundle and gas gland; the presence of an oval could not be established.

*Coloration*: From an Ektachrome transparency taken soon after death: Most of body translucent with brownish-orange, black and white markings; tip of lower jaw brownish-orange; snout and post-ocular region without a well defined stripe, but with some orange pigment; base of caudal with a brownish-orange bar and a smaller adjacent white spot positioned anterodorsally; another white spot at base of last dorsal ray; a black area around anus; cheek and abdomen silvery.

*Coloration in 55% isopropyl alcohol*: All fins pale and translucent; a faint basicaudal mark displaced slightly dorsal to the pored lateral line scales; a dusky stripe on snout to tip of lower jaw; only nape scales outlined with dark chromatophores; anal and genital openings surrounded by circular black spot; peritoneum white with many small dark chromatophores; intestine and stomach black.

*Distribution*: *Apogon melanoproctus* is known from one collection of 12 specimens from the Solomon Islands.

*Holotype*: BPBM 15474 (40.0 mm SL), Solomon Islands, Florida, Island, south side of Tanavula Point, 09°02′44″S, 160°04′07″E, vertical reef wall with caves, 18–37 m, 30 July 1973, J. E. Randall and G. R. Allen.

*Paratypes*: (All same data as holotype) USNM 212133 (1 specimen, 38.8 mm, cleared and stained), USNM 212132 (2, 36.0–38.1), RMNH 27056 (2, 36.5–37.5), BPBM 15475 (2, 37.2–38.0), CAS 30649 (2, 30.1–37.3), AMS I. 17888-001 (2, 34.5–37.2).

*Etymology*: The name *melanoproctus* is a Greek noun from *melanos*, black, and *proktos*, anus. It refers to the black pigment that completely surrounds the anus.

*Discussion*: These two species are closely related to each other, based on the combination of seven visible first dorsal spines, two predorsal bones, a pair of uroneurals and similar body shapes and dentition. The combination of two predorsal bones and seven spines in the first dorsal is unusual in seven-spined species of *Apogon* and is known only to occur in *Apogon queketti* Gilchrist, out of the approximately 49 seven-spined species examined by Fraser (1972) in the subgenera *Nectamia* and *Pristiapogon*. The new species do not belong to the group of species that includes *A. queketti* nor do they belong in *Pristiapogon*. We tentatively assign the new cardinalfishes to the subgenus *Nectamia*. The subgeneric classification of *Apogon* proposed by Fraser (1972) was based on the osteological study of about 80 of the approximately 130 valid species. Future evaluation (now in progress) of the subgenera and species groups is necessary before stable and, hopefully, definitive understanding of this large genus is attained. *Apogon dispar* and *melanoproctus* may eventually warrant subgeneric designation.

Like other deeper-dwelling reef apogonids, we expect these species to have wider distributions than are presently recorded.

## Literature Cited

Fraser, T. H. 1972. Comparative osteology of the shallow-water cardinal fishes (Perciformes: Apogonidae) with reference to the systematics and evolution of the family. Ichthyol. Bull. Rhodes Univ. 34:i–v, 1–105, 43 pls., 6 tabs.

QH
1
B4X
NH

No. 48, pp. 509–514 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

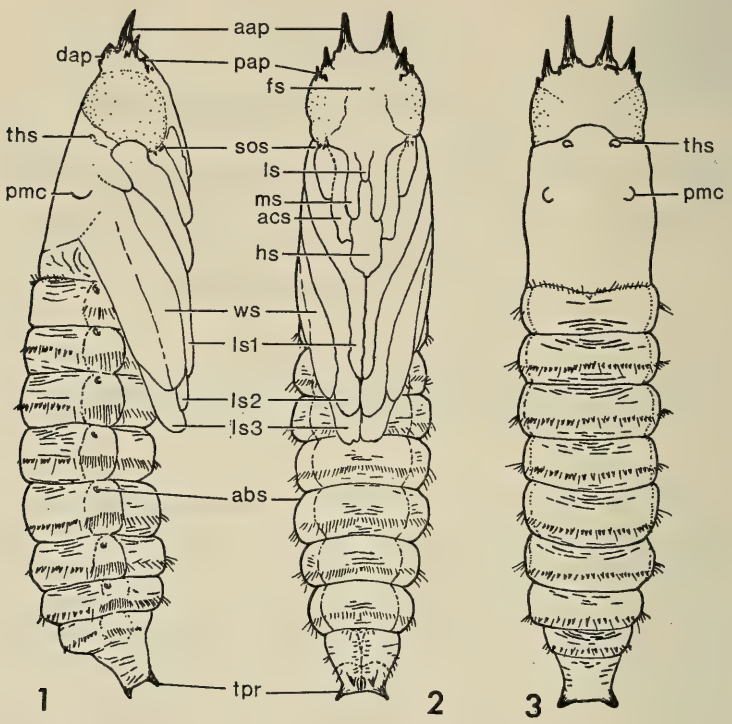
# KEY TO SUBFAMILIES OF ROBBER FLIES BASED ON PUPAL CASES, WITH A DESCRIPTION OF THE PUPAL CASE OF *DORYCLUS DISTENDENS* (ASILIDAE: MEGAPODINAE)

By Lloyd Knutson
*Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA, Beltsville, Maryland 20705*

The immature stages of Asilidae are poorly known, as are those of most other families of Diptera. In my review (Knutson, 1972), I noted that only about 2% of the approximately 5,000 world species of Asilidae are known in any immature stage. Only four of the five generally recognized subfamilies are included in this number. Most of the relatively few genera and species for which descriptions of immature stages are available are members of the three largest subfamilies (Asilinae, Dasypogoninae, and Laphriinae). Limited data are available for the Leptogastrinae. Until now, nothing has been published on the immature stages of the remaining subfamily, the Megapodinae.

*Doryclus distendens* (Wiedemann)
Megapodinae
Pupal case (Figures 1–3)

Length (including anterior antennal processes), 10.8–12.8 mm; greatest width of thorax, 2.3–3.0 mm; greatest width of abdomen, 2.4–3.2 mm, tapering to 1.5–2.0 mm at greatest width of last abdominal segment. Subshining straw yellow, integumentary processes glistening reddish brown. Head with a pair of large, acuminate, straight anterior antennal processes (aap) not joined at base, a group of 3–4 basally confluent posterior antennal processes (pap), and one truncate dorsal antennal process (dap) at base of each anterior antennal process. Facial area with a pair of small medial spines (fs). Labral sheath (ls) and hypopharyngeal sheath (hs) elongate and smooth. Maxillary sheath




FIGS. 1–3. *Doryclus distendens* (Wiedemann), pupal case. 1, lateral view; 2, ventral view; 3, dorsal view. aap, anterior antennal process; abs, abdominal spiracle; acs, anterior coxal sheath; dap, dorsal antennal process; fs, facial spines; hs, hypopharyngeal sheath; ls 1, 2, 3, leg sheaths; ls, labral sheath; ms, maxillary sheath; pap, posterior antennal process; pmc, posterior mesothoracic callosity; sos, suborbital spine; ths, thoracic spiracle; tpr, terminal process; ws, wing sheath.

(ms) with pair of elongate areas extending below labral sheath, almost to apex of anterior coxal sheath (acs). Two or three suborbital spines (sos) on either side of head ventrolaterally above base of anterior coxal sheath. Paired thoracic spiracles (ths) elongate oval, surrounded by a C-shaped ring of thickened cuticle, situated dorsally at anterior margin of thorax on rugulose area. Without anterior or posterior mesothoracic spines, but with a well developed posterior mesothoracic callosity (pmc) at base of wing. Sheaths of third pair of legs reaching anterior margin of abdominal segment 4. First abdominal segment with dorsal transverse row of about 30 erect, subequal, more or less uniformly shaped, straight, spinelike, yellowish processes; about 8 similar processes in

transverse row behind abdominal spiracle (abs); venter obscured. Second segment with median transverse row of about 20 short, stout, dull, dark, posteriorly directed processes, and with elongate, straight, yellowish spinelike processes interspersed between every 3rd stout process dorsally; about 11 such spinelike processes laterally on each side behind spiracle, and a mesally interrupted row of such spines ventrally. Third through seventh abdominal segments similar to each other, each with stout processes and spinelike processes dorsally as on second segment, with stout processes becoming recurved to erect, and sharper on posterior segment; 10–16 spinelike processes laterally behind each abdominal spiracle, and complete transverse row of spinelike processes ventrally. Abdominal segment 8 (terminal segment) composed of a ringlike anterior portion with a transverse circlet of processes, interrupted midventrally or absent ventrally, and a tapered posterior portion with a pair of strong, dark, dorsolateral terminal processes and a silghtly smaller pair of ventral terminal processes (tpr).

Martin and Papavero (1970) gave the distribution of *D. distendens* as, "Brasil: Santa Catarina. Para, Santarem." Six pupal cases of *D. distendens* are in the collection of the U.S. National Museum, Washington. Three specimens are labeled only, "Z-3224", "A. E. Pritchard Collection, 1962." Three other specimens are labeled, "Parita, Panama, Zetek #1689;" one of the latter pupal cases contains a well-formed, partially emerged adult. Bromley (1951) was apparently referring to these six specimens when he noted "The Megapodinae are wasp-like in appearance and are undoubtedly mimetic of certain aculeate Hymenoptera with which they are associated in a Mullerian association. Their affinities with the other Laphriinae are indicated by the fact that their larval and pupal stages take place in decaying wood. Dr. Zetek has reared certain species of this group from hollow citrus trees in Panama."

## The Subfamily Classification of Asilidae

Various authors have used two, three, four, five, or eight subfamilies for the classification of the approximately 400 world genera of Asilidae. Bromley (1946) recognized four subfamilies: Asilinae, Dasypogoninae, Laphriinae, and Leptogastrinae. Hull (1962) recognized five subfamilies: Asilinae, Dasypogoninae, Laphriinae, Leptogastrinae, and Megapodinae. Martin (1968) raised the Leptogastrinae to family status. Martin and Papavero (1970) recognized only three subfamilies, considering the Laphriinae to represent tribes in the Dasypogoninae, and the Leptogastrinae as a separate family. Papavero (1973a) recognized eight subfamilies of Asilidae (Apocleinae, Asilinae, Dasypogoninae, Laphriinae, Laphystiinae, Ommatiinae, Stenopogoninae, and Trigonomiminae).

Carrera (1949) proposed the tribe Megapodini for five Neotropical genera (*Doryclus* Jaennicke, *Megapoda* Macquart, *Pronomopsis* Hermann, *Pseudorus* Walker, and *Senobasis* Macquart). The Megapodini were raised to subfamily rank by Hull (1962). Forty-three species of Mega-

podinae in six Neotropical genera (the above five genera plus *Pseudoryclus* Carrera) were recognized by Martin and Papavero (1970). Oldroyd (1974) p. 17, commented, "Hull is, therefore, justified in retaining this tribe [Megapodini], though perhaps not in raising it to the status of a subfamily." Papavero (1973b) included *Lagodias* Loew (Ethiopian, Palearctic, and Oriental Regions) and *Pegasimallus* Loew (Ethiopian Region) with the six Neotropical genera mentioned above in the tribe Megapodini, subfamily Dasypogoninae.

Papavero's tentative classification of the subfamilies is based on phylogenetic considerations, is worldwide in scope, and is probably a better arrangement than the classifications of previous authors. However, to facilitate identification of asilid pupae and pupal skins and for the purposes of the key presented below, I am recognizing the five groups accorded subfamily status by Hull (1962).

### Key to Subfamilies of Asilidae Based on Pupal Cases

1. Anterior antennal processes small, truncate; posterior antennal processes absent; last abdominal segment with only 1 pair of terminal processes; abdomen laterally with elongate (longer than length of segment), hairlike processes ..... Leptogastrinae
   Anterior antennal processes large, acuminate; posterior antennal processes present; last abdominal segment with 2–6 pairs of terminal processes; abdomen laterally with short (shorter than length of segment), spinelike processes ..... 2
2. Dorsal antennal processes present; anterior antennal processes almost straight; without anterior or posterior mesothoracic spines, but with posterior mesothoracic callosity; with suborbital spines and medial facial spines ..... Megapodinae
   Dorsal antennal processes absent; anterior antennal processes somewhat curved ventrad; with anterior and/or posterior mesothoracic spines, without suborbital spines; with or without medial or lateral facial spines ..... 3
3. Lower face with small medial or lateral spines; posterior antennal processes usually with 4–5 confluent hooks each ..... Laphriinae
   Lower face without medial or lateral spines; posterior antennal processes usually with 3 confluent hooks each ..... 4
4. Abdomen laterally behind spiracles usually with only 3 spinelike processes on each side; last abdominal segment with 2 or more pairs of terminal processes ..... Dasypogoninae
   Abdomen laterally behind spiracles usually with more than 5 spinelike processes on each side; last abdominal segment with 4 pairs of terminal processes ..... Asilinae

### Acknowledgments

I thank Miss Pamela Hollyoak for preparing the illustrations and Drs. D. Steve Dennis, Robert J. Lavigne, Nelson Papavero, and Aubrey G. Scarbrough for reviewing the manuscript.

## Literature Cited

Bromley, S. W. 1946. Third fascicle. Asilidae. *In* Guide to the insects of Connecticut. Pt. VI. The Diptera or true flies of Connecticut. Conn. Geol. Nat. Hist. Surv. Bull. 69. viii + 51 pp.

———. 1951. Asilid notes (Diptera), with descriptions of thirty-two new species. Amer. Mus. Novitates No. 1532:1–36.

Carrera, M. 1949. Contribuicao ao conhecimenta dos Asilidae Neotropicais (Diptera). Arq. Zool., São Paulo 7(1):1–148.

Hull, F. M. 1962. Robber Flies of the World. The genera of the family Asilidae. U.S. Nat. Mus. Bull. 224, pt. 1:i–x, 1–430; pt. 2:433–907.

Knutson, L V. 1972. Pupa of *Neomochtherus angustipennis* (Hine), with notes on feeding habits of robber flies and a review of publications on morphology of immature stages (Diptera: Asilidae). Proc. Biol. Soc. Wash. 85:163–178.

Martin, C. H. 1968. The new family Leptogastridae (the Grass Flies) compared with the Asilidae (Robber Flies) (Diptera). Jour. Kans. Entomol. Soc. 41:70–100.

Martin, C. H., and N. Papavero. 1970. Family Asilidae. Fascicle 35b:1–139. *In* a Catalogue of the Diptera of the Americas South of the United States. Mus. Zool., Univ. São Paulo, São Paulo, Brazil.

Oldroyd, H. 1974. Some comments on the tribal classification of Asilidae (Diptera). Israel Jour. Entomol. 9:5–21.

Papavero, N. 1973a. Studies of Asilidae (Diptera) systematics and evolution. I. A preliminary classification in subfamilies. Arq. Zool., São Paulo 23(3):217–274.

———. 1973b. Studies of Asilidae (Diptera) systematics and evolution. II. The tribes of Dasypogoninae. Arq. Zool., São Paulo 23(4):275–294.

QH
1
B4X
NH

No. 49, pp. 515–548 22 January 1976

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

# CLARIFICATION OF FIVE GENERA OF PHOXOCEPHALIDAE (MARINE AMPHIPODA)[1]

By J. Laurens Barnard and Margaret M. Drummond
*Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C. 20560, and Fisheries and Wildlife Division, Marine Pollution Studies Group, 605 Flinders St. Extension, Melbourne, Victoria 3000, Australia*

The following four genera were treated as subjective synonyms of *Paraphoxus* Sars, 1895, by J. L. Barnard (1960): *Pontharpinia* Stebbing, 1897, *Parharpinia* Stebbing, 1899, *Protophoxus* K. H. Barnard, 1930, and *Trichophoxus* K. H. Barnard, 1930. We present new evidence to effect their revival and to suggest that a fifth genus, *Metharpinia* Schellenberg, 1931, is also valid. We have examined the type-species of all genera except *Metharpinia* and have found minute characters, heretofore unreported, that confirm the distinction of the genera. This study is an outgrowth of a larger work, in preparation, concerning 86 species in 23 genera of Australian Phoxocephalidae. All but three of the Australian genera are new and 80 of the 86 species are new. This pool of taxa approximately doubles the number of species and genera in this family and has given us new information on the generic classification of Phoxocephalidae. We believe that the Australian fauna of Phoxocephalidae contains the most primitive living members of the family but also contains an array of highly advanced genera so as to present a full display of systematic modifications in generic characters. The Australian fauna contains one new endemic genus with 38 species, several new genera with 4–8 species and many others with fewer species. The tightly knit generic characterization of the largest genus,

[1] Publ. 35 in the Ministry of Conservation, Victoria, Environmental Studies Series.

allied with the demonstrated cohesiveness of characters in the genera comprising 4–8 species, provides a background out of which the generic validity of *Pontharpinia*, *Parharpinia*, *Protophoxus* and *Trichophoxus* can be established. The large genus, *Birubius*, is established with its type-species but the other 37 species are reserved for description in another place (Barnard and Drummond, in prep.).

## Materials and Methods

Specimens of the type-species of the 4 genera (2 of these Australian) to be reestablished plus 84 other Australian species in 21 genera and 20 additional species formerly assigned to *Paraphoxus* have been examined. Approximately 250 characters have been analyzed in each species. Many of these are characters not heretofore considered as important for recording in Phoxocephalidae and might be termed "minute" or "trivial" characters, for example, the presence, number, size and groupings of spines on the medial surfaces of appendages. Among many other "trivial" characters, the fine structure of right lacinia mobili and of cuticular setules has also been examined. Many of the characters actually are class-characters, those in which numerous alternatives of condition have evolved. Many new kinds of attributes have been discovered, mainly those occuring in Australian species but rarely elsewhere as far as we can determine from the phoxocephalid literature. For example, several genera, including *Trichophoxus*, to be revived, bear a spike on uropod 1, composed of a large interramal spine on a ventral protrusion of the peduncle. Characters such as "non-skid" cuticle, heretofore found only in genera of nonphoxocephalid families are found to occur in Australian species. A list of these characters will be presented by Barnard and Drummond (in prep.).

The 86 Australian species were arranged in species clusters according to subjective appraisal of their common characters and the clusters then ordered in numerous trials based on models concerning evolutionary flow in morphocharacters. The main precept of each model was a manifold series of decisions as to the primitive or advanced state of each of the characters, these being juxtaposed and evaluated simulta-

neously in each model. The principle of parsimony was applied to the system and the tenet of irreversibility was adopted, so that once an attribute was lost entirely it could not be regained in a later step. The large genus, *Birubius*, originally comprising 40 species assembled by subjective taxonomic means, was found to have 9 clusters of species. One of these clusters, of 2 species, was found to have qualitative characters separating it from the other 8 clusters. The characters were seen to have apparent generic significance when compared with characters in other taxa. Those other genera had been separated by ordinary taxonomic evaluations and not by clustering methods. The distinctions, comprising fully qualitative characters, found in the separation of 2 species from 38 others, suggested the need to search for similar kinds of distinctions in an overall generic analysis of 86 species. The 8 clusters remaining in the large genus were found to be differentiated only by quantitative characters. We define "qualitative" as meaning present or absent; we define "quantitative" either as being slightly different in shape, proportion, degree and count, or subject to evidence of intergradation from one extreme to another, such as an accessory nail being represented in another species by a vestigial setule. These manipulations were extended to the remaining Australian phoxocephalids so as to result in 86 species being divided among 23 genera. The nomenclature of the genera was then rectified by examining the type-species of named genera and fitting those species to the generic pool. In this process we determined that the 4 genera to be reestablished in this paper are highly distinctive and not synonymous with *Paraphoxus*.

Pereopods are counted as gnathopods 1–2 and pereopods 3–7. The term "mark" (M.) refers to a stated distance from a basal point on a 0 to 100 scale. The term "ordinary" is used in the descriptions to avoid lengthy explanation for characteristics of common occurrence in phoxocephalids. An ordinary rostrum is elongate and unconstricted from dorsal aspect. Ordinary setation on maxilla 2 is a contrast apposed to "weak" setation and is a subjective value judgment. Ordinary inner plates of the maxilliped are broad, elongate, and unfused medially. Ordinary pereopod 7 refers to the great size

of this appendage and its lack of facial setae. The contrast to ordinary refers to the highly miniaturized pereopod 5 of *Trichophoxus* (see illustrations). The term "mitelloid" refers to the shape of the hands on gnathopods 1–2 in *Trichophoxus* which resemble goose-neck barnacles. An epimeron 3 of "rounded-classification" bears a convex posterior margin, no posteroventral tooth and, in addition, has fewer than 3 long setae anywhere on the epimeron. Occasional examples of this kind of epimeron may have 3 extremely small setules posteroventrally. The "special spine" on the peduncle of uropod 1 refers to its displacement on the apex in a ventral direction away from the dorsal margin of the peduncle. Broad and narrow forms of article 2 on pereopod 5 refer to vastly distinctive alternatives in width of that article. Facial counts of spines on article 4 of antenna 1 commence at the distal end. Spine and seta counts on article 1 of the outer ramus on uropod 3 commence proximally; the lateral margin bears acclivities each with one or more spines and setae, thus the formula, acclivities = 8, spines = $0 \times 5$, $1 \times 4$, setae = $1 \times 5$, $2 \times 2$ and $2 \times 3$ translates to "spine absent on first 5 acclivities, one seta present on each of next 3 acclivities plus apex of article (counted as ninth armament position), one seta on each of first 5 acclivities, 2 each on next 2 acclivities, 3 each on next acclivity plus apex."

## History of the *Paraphoxus* Problem

*Paraphoxus* Sars, 1895, based on *P. oculatus* (Sars), was established to separate that species from the familial type-genus, *Phoxocephalus* Stebbing, on the equality of gnathopods and the nontriturative molar. *Paraphoxus oculatus* is primarily a northern coolwater species widely distributed in the Atlantic and Pacific Oceans. In the description of the genus Sars erred in stating that the first maxillary palp is uniarticulate; instead, it is biarticulate. This unfortunate error in an otherwise superlative description commenced a series of missteps culminating in the gradual amalgamation of several phoxocephalid genera described in later years. The final result was the synonymy promulgated by J. L. Barnard (1960) in which *Pontharpinia*, *Parharpinia*, *Protophoxus* and *Tricho-*

*phoxus* were treated as subjective junior synonyms of *Paraphoxus*. Many good taxonomic characters had been overlooked by that time, those characters having been considered to be valuable only at specific level.

Stebbing (1897) established *Pontharpinia* for *Urothoe pinguis* Haswell, 1879b. Stebbing did not mention *Paraphoxus* in his comparisons, and unfortunately his diagnosis is erroneous because he did not have in hand *Urothoe pinguis* Haswell but another species of phoxocephalid now known as *Paraphoxus stebbingi* J. L. Barnard, 1958. We have learned that *pinguis* and *stebbingi* are not congeneric, indeed they are vastly different and probably should be relegated to distinct subfamilies (to be considered elsewhere) within the Phoxocephalidae. Although *Pontharpinia* is a confounded genus we believe that it should be retained, with *Urothoe pinguis* as type-species; a new diagnosis of the genus is presented below. *Paraphoxus stebbingi* belongs to a new genus with affinities to *Trichophoxus*. That genus will be described elsewhere but Stebbing's species will not be designated as the type-species. Although we recognize the genus to which *P. stebbingi* belongs, we have been unable to locate Stebbing's specimen either in the British Museum of Natural History, the Universitets Zoologiske Museum in Copenhagen or The Australian Museum.

In the Australian study we have not been able to identify *stebbingi* among the 5 species in the genus. The specimen Stebbing had in hand was one set to him by Haswell long after the establishment of *U. pinguis* and from a different site than the type-locality. Stebbing's *Pontharpinia* was included in a paper otherwise concentrated on collections of the Copenhagen Museum but apparently the specimen was not given to the Copenhagen Museum nor returned to Haswell and deposited in the Australian Museum, nor was it given to Stebbing's national museum, the British Museum of Natural History. To trace the exact species Stebbing had in hand may require investigation of the kinds of amphipods in Jervis Bay, New South Wales, the original site of Stebbing's specimen.

The 5 species of the new genus, to be described, that will contain *Paraphoxus stebbingi*, are characterized interspecifically by spination patterns on uropods 1–2 and the pres-

ence, absence, or degree of development of combs on those uropods. The crucial description of these parts was not given by Stebbing.

*Pontharpinia* is highly distinct from *Paraphoxus*. J. L. Barnard (1960) made a partial evaluation of the type-species *pinguis* based on notes made by K. Sheard and concluded that the genus was synonymous with *Paraphoxus*. Unfortunately the mandible of the so-called type-specimen was missing; that mandibular molar is triturative, thus demonstrating a strong distinction. We have now identified numerous specimens of *pinguis* by comparison with that so-called type-specimen and with Haswell's description and find numerous distinctions from *Paraphoxus* as outlined in the generic diagnosis to follow.

Stebbing (1899) established *Parharpinia* in a short paragraph, with *Phoxus villosus* Haswell, 1879a, as type-species. Again, this is a confounded genus because Stebbing had in hand a specimen from New Zealand loaned to him by G. M. Thomson and identified as *Phoxus batei*. Stebbing was under the impression that this entity was synonymous with *Phoxus villosus* from Australia. Hurley (1954) demonstrated that the specimen identified by Thomson as *P. batei* is in fact *Pontharpinia australis* (K. H. Barnard), originally described as the type-species of *Protophoxus* and now to be returned to that appellation. *Phoxus batei* Haswell 1879a, itself is a good species to be relegated to *Birubius*, new genus. Stebbing (1906) relegated *P. batei* to *P. rostratus* (Dana, 1853), but that synonymy cannot be supported. Parenthetically, the so-called original material of *Phoxus batei* is confounded; the specimens labeled *Phoxus batei* residing in the Australian Museum are clearly not what Haswell described; we can identify what Haswell described with fair precision. J. L. Barnard (1974) discussed this recurrent problem that most, if not all, of Haswell's amphipod types were labeled "Type" or perhaps reidentified at a much later date, between 24 and 74 years after the fact, some apparently in the early 1900's by unknown hands but some as late as the 1950's by the late Dr. Sheard. In most cases the later selection was correct, but, the specimens selected for *P. batei* belong to *Birubius*. We believe that in most

cases Haswell did not participate in the selection of specimens labeled "Type" and that therefore they would qualify, at best, as lectotypes, once codified by publication as such. We intend to ignore publishing the specimen of *P. batei* now called "Type" so as to conserve Haswell's name for an easily recognized species.

We now know that *Parharpinia* differs from *Paraphoxus* in numerous characters as seen in the diagnoses to follow but more importantly, *Parharpinia*, with 2 species in Australia, forms a genus with intergradations between *Birubius*, the basic *Australian* genus (containing 38 species), and the two groups of genera to which *Trichophoxus* and *Protophoxus* belong. *Birubius* carries only apicoposterior telsonic spines, whereas *Parharpinia* carries dorsal telsonic spines or setae and furthermore bears a special spine on uropod 1. *Parharpinia* also appears to be near the ancestral pool for several other new Australian genera by virtue of posterior setation on epimera 1–2.

*Protophoxus* K. H. Barnard, 1930, for *P. australis* K. H. Barnard, 1930, was described sketchily to distinguish a species thought by Barnard to bear relationship to *Phoxocephalus* and therefore was distinguished from that genus but not from *Paraphoxus* nor *Pontharpinia*. The latter genus had by that time become the repository for the bulk of paraphoxinlike species because those species fitted the diagnosis of *Pontharpinia* best in light of its known biarticulate palp of the first maxilla and the broad pereopods 5–6; other species had, however, been placed in *Parharpinia* to fit the concept of thin pereopods 5–6. K. H. Barnard's diagnosis of *Protophoxus* contained only 2 characters. the biarticulate palp of maxilla 1 and the elongate wrists of the gnathopods. Five figures, i.e., gnathopods 1 and 2, epimeron 3, telson and a sketch of antenna 2 plus a medium-sized description established the type-species. We now recognize that the presence of dorsal spines on the telson is the best clue to suggest that *Protophoxus* bears no relationship to *Paraphoxus*. Hurley (1954) redescribed *"Pontharpinia" australis* from a specimen collected a few hundred miles from the type-locality and which differed, as far as Hurley could distinguish from the meager first description, only in the reduced number of dorsal telsonic spines. We have

now reexamined some of the syntypes of *P. australis* and find Hurley's excellent portrayal of the species to be exact and the distinction he noted to be minor but perhaps indicative of infraspeciation, perhaps a reflecton of clinal phenotypy. *Protophoxus* bears a close resemblance to *Parharpinia*, especially in the presence of dorsal spination or setation on the telson. But several good generic distinctions separate the 2 taxa as stated in the diagnoses to follow. Each genus has a special spine on uropod 1 but on opposite sides from each other.

*Trichophoxus* was established by K. H. Barnard, 1930, for *T. capillatus* K. H. Barnard, 1930, again in comparison to *Phoxocephalus* and with a short diagnosis confined to "mandible with molar conical, lacking the triturating surface, and tipped with 4 strong spines; and 5th joint of both gnathopods elongate." Illustrations of head, gnathopod 1, antenna 1, telson, epimeron 3 and pereopod 7 accompanied a medium-sized description. We now know that various characters on pereopod 7, gnathopod 1 and the telson have generic value. The written description of the mandibular molar weakly fits the general situation in *Paraphoxus* and in the supposed but confounded descriptions cited for *Parharpinia* and *Pontharpinia*. We have examined and established a lectotype for *T. capillatus* and have determined that this molar is actually distinct in high degree from the molar attributed to various species formerly placed in *Paraphoxus*, *Pontharpinia* and *Parharpinia*. The molar is large, subconical, but truncate, has a definite semiarticulate base and bears 4 very large spines only partly articulate and consistently fixed in a pattern of size and shape (see illustrations). We confirm the consistency of this molar in 5 species of a related new genus from Australia and in *Paraphoxus rakiura* Cooper and Fincham, 1974, a species from New Zealand which should be transferred to a new and distinctive genus based on patterns of uropodal spination and setation.

*Metharpinia* Schellenberg, 1931, was described for 2 species, *M. longirostris* Schellenberg, 1931, and *M. cornuta* Schellenberg, 1931, neither of which, as yet, has been designated as type-species of the genus. Although J. L. Barnard (1960) reexamined these species, few new observations were pub-

lished. The lateral setation of the telson suggests generic differentiation from those genera diagnosed herein but numerous other minute details must be determined before a type-species is selected and the genus revived.

During the years between 1906 and 1957 three species of phoxocephalid were described in *Paraphoxus*, 9 in *Pontharpinia* (with 3 additional synonyms) and 7 species in *Parharpinia.* Apparently these species were assigned to genera mainly on the basis of Stebbing's (1906) key to the genera of *Phoxocephalidae*, in which *Paraphoxus* was erroneously attributed a uniarticulate palp on maxilla 1, *Pontharpinia* was erroneously attributed a nontriturative mandibular molar and *Pontharpinia* and *Parharpinia* were distinguished on the stoutness of pereopods 5–6. Apparently the species assigned to *Paraphoxus* were placed there mainly on the overall facies rather than on the condition of maxilla 1.

J. L. Barnard (1960) in assembling a pool of 40 species, synonymized all of these genera on the thesis that stoutness of pereopods 5–6 was variable in the pool of species being treated, that all were known or suspected to have a biarticulate palp on maxilla 1, that the elongation of article 5 on gnathopods was variable and that widths of rostra were variable. All were presumed to have a simple mandibular molar bearing a few semiarticulate, tightly clumped spines, a fact we now know to be erroneous in *Trichophoxus* and *Pontharpinia*; and we now know that the kind of spine clumping on the molar of *Paraphoxus* is a good generic character.

Our study of Australian phoxocephalids demonstrates a secondary importance of rostral dimensions as a generic character and an imperfect association between pereopodal widths and generic or subfamilial categorizations, but many of the following characters should be brought into the pool of important characters: fine structure of molars, proportions of and setal distribution on article 2 of antenna 1 and on article 5 of antenna 2, facial spine and setal distributions on articles 3–4 of antenna 2, shapes and dominance of epistome and upper lip but not necessarily the degree of cuspidation, size of palpar hump on mandible, presence or absence of cones on the lower lip, setation counts on the inner plate of maxilla 1,

degree of cleft between inner lobes of the maxillipeds, linear or nonlinear arrangement of facial setae on article 3 of the maxillipedal palp, length and shape of the dactyl on the maxilipeds and the condition of the apical nail and attendant accessory setae, shapes and setosity of gnathopods in terms of shortened and cryptic article 5, anterior setal density on hands, degree of palmar slope, enlargement of gnathopod 2 and eusirid-like attachments of articles, presence or absence of posteroproximal setae on article 5 of pereopods 3–4, presence and size of midapical subdactylar spine on article 6 of pereopods 3–4, apical ornamentation of dactyls on pereopods 3–4, size and shape of pereopod 7 articles 2–3, presence or absence of dactyl on pereopod 7, presence or absence of combs in various places on pereopods and uropods including medial surfaces and rami, presence or absence of long flexible setae in various places on epimera and uropods, numbers and shape of apical setae on article 2 of outer ramus on uropod 3, presence or absence or degree of development of thick spines on uropods and urosomal surfaces, lengths of rami of uropods 1–2 with special attention to inner ramus of uropod 2, degree of fusion of inner ramus of uropod 2 to peduncle, size and presence of glandular tissue in urosome, fusion, setation and presence of spines on urosomites, presence and number of apical, dorsal and lateral spines on telson, and, finally, gill formulas.

### *Paraphoxus* Sars

*Paraphoxus* Sars, 1895: 148–149.

*Diagnosis of male and female*: Eyes present; flagella of antennae 1–2 unreduced, article 1 of antenna 1 bearing medial fuzz in male, article 2 short, setae confined distally, primary flagellum with calceoli in male; antenna 2 lacking ensiform process, article 3 with only 2 facial setules, apicalmost elongate, article 5 somewhat shortened, bearing dorsal calceoli in male, flagellum with calceoli in male; upper lip and epistome distinct, epistome dominant; right mandibular incisor with 3 teeth, molar not triturative, small, forming weakly conical boss, bearing clump of 3 articulate spines on basal plate, no fuzz, right lacinia mobilis bifid, rami subequal in length, lacking facial denticles, palper hump of mandible small; lower lip bearing cones; palp of maxilla 1 biarticulate, inner plate with 2 setae; inner plates of maxilliped ordinary, poorly setose, palp article 3 scarcely protuberant, dactyl elongate, apical nail elongate, not

immersed; gnathopods small but hands weakly enlarged, almost identical in shape, article 5 shortened, hands ovatorectangular, poorly setose anteriorly, palms oblique; article 5 of pereopods 3–4 bearing setae posteroproximally but not fully to base, article 6 bearing normal 2 rows of spines, middistal armament absent, dactyls lacking inner tooth, bearing subapical slit, apical nail distinct but partly immersed; article 2 of pereopod 5 of broad form, untapering, of pereopod 7 of ordinary phoxocephalid kind, article 3 of pereopod 7 small (ordinary), articles 4–5 of pereopods 5–6 narrow, pereopod 7 of normal size, article 2 ventrally naked (lacking long setae); peduncular apices of uropods 1–2 minutely combed, peduncle of uropod 1 normally elongate, lacking ventral spike or special spines, medial spines widely spread, dorsal spines confined apically (not shown in Sars, 1895), inner ramus of uropod 1 bearing only 1 row of spines, peduncle of uropod 2 with 1 short medial spine set apically plus 1 midmedial seta, inner ramus spinose, as long as outer ramus, uropod 3 especially elongate, article 2 of outer ramus with only 2 apical setae; telson naked laterally and dorsally except for normal pair of setules set about mark 50 (not shown in Sars, 1895); urosomite 1 devoid of major lateral spines and ventral setae; epimera 1–2 lacking posterior setae, with facial setae located ventrally (not shown in Sars, 1895), none in midface, epimeron 3 lacking posterior setae, of special "rounded-classification" form, lacking midfacial setae or spines.

*Description*: Rostrum large and broad; facial spines on article 4 of antenna 2 primarily in one row, but second row of one spine and setule present, article 5 thin; article 1 of mandibular palp weakly elongate, apex of article 3 truncate but scarcely oblique, palp thin, distal branch of right lacinia mobilis broad, serrate minutely, proximal branch like raker spine; outer plate of maxilla 1 with 11 spines plus inner articulate apical plumose seta (not shown in Sars, 1895), one spine especially thickened; setation of maxilla 2 ordinary; inner and outer plates of maxilliped ordinary but inner plate poorly setose, lacking thick apical spine(s) [this character not confirmed]; coxae 2–4 lacking anterodorsal humps; article 5 of gnathopod 2 free (not cryptic); article 2 of pereopod 7 with small posterior teeth, lacking facial setae; gills present on pereonites 2–7.

*Type-species*: *Phoxus oculatus* Sars, 1879 (monotypy).

*Composition*: The type-species and possibly *Parharpinia simplex* Gurjanova, 1938. All other species ever assigned to *Paraphoxus* are to be removed to other genera, mostly new. See "Allocation in *Paraphoxus*" to follow.

*Relationship*: Our study of Australian phoxocephalids has revealed a group of 5 new genera containing 9 species in which *Paraphoxus* fits as a highly specialized and advanced taxon from cool waters of the northern hemisphere. This group of genera is distinguished by the following combination of characters: (1) the sole presence on the mandibular molar of a group of 3 tightly packed and partly fused (basal) spines (inadequately shown in Sars, 1895); (2) article 2 of antenna 1

short; (3) all thick facial spines on article 4 of antenna 2 peduncle aligned in a single row; (4) setae on inner plate of maxilla 1 reduced in number from the usual 4 found in primitive Australian genera; (5) article 2 of pereopods 6–7 with only one main facial ridge; (6) inner plate of maxilliped lacking stout apical spines; (7) epimeron 3 of "rounded-classification", lacking any elongate setae, protruding posteriorly, and, at most, bearing 3 setule notches. The following characters are often useful in recognizing members of this generic group but the characters are not universally present: (1) apical combs on the peduncles of uropods 1–2; (2) articles 4–5 of pereopods 5–6 very thin (with one weak exception); (3) article 5 of antenna 2 shortened in females, this observation based on primitive phoxocephalids bearing a more elongate article 5; (4) article 6 of pereopods 3–4 with some component spines elongate and thin, almost classifiable as flexible setae (with 2 generic exceptions). These genera also share numerous other similarities most of which in the broader context are useful in genera outside this system at specific level. One example is the absence of accessory apical nails on the rami of uropods 1–2; in certain new Australian genera the presence or absence of these accessory nails is useful taxonomically only at specific level; another example is the presence of a special cusp or articulate setule medially on the outer plate of maxilla 1.

The Australian genera of this complex can be arranged in an evolutionary sequence to demonstrate that in the primitive state taxa are characterized by an enlarged gnathopod 2 with cryptic article 5, whereas in the advanced or specialized state gnathopod 2 is reduced to a size similar to gnathopod 1, with the posterior margin of article 5 free from envelopment. *Paraphoxus* represents the advanced state of this condition.

The characters of the generic diagnosis have been confirmed from material of *Paraphoxus oculatus* (Sars) deposited in the U.S. National Museum of Natural History and identified by comparison to pl. 51 of Sars, 1895.

## Allocation of Species in *Paraphoxus*

Those species formerly assigned to *Paraphoxus* not now confined to the genera herein restricted must be removed from *Paraphoxus* and allocated to newly created genera. This process is difficult because many of the species are poorly described and cannot be so allocated until they have been reexamined minutely. We detect a pattern of classification in the species adequately described as outlined below. New genera for these taxa will be described elsewhere.

I. Peduncle of uropod 1 with special medial spine.
   A. Pereopods 5–6 with stout articles 4–5; wrists of gnathopod 2 slightly elongate.
      *Pontharpinia epistoma* Shoemaker, 1938: 326; J. L. Barnard, 1960: 205 (as *Paraphoxus*); Bousfield, 1973: 126 (as *Trichophoxus*)

*Pontharpinia floridana* Shoemaker, 1933: 5; J. L. Barnard, 1960: 226 (as *Paraphoxus*)
*Paraphoxus gemmatus* J. L. Barnard, 1969: 222
*Paraphoxus jonesi* J. L. Barnard, 1963: 463
*Paraphoxus lucubrans* J. L. Barnard, 1960: 212

B. Pereopods 5–6 with thin articles 4–5.
1. Wrist of gnathopod 2 shortened; setae on article 2 of antenna 1 widely spread.
*Paraphoxus cognatus* J. L. Barnard, 1960: 233
?*Parharpinia fuegiensis* Schellenberg, 1931: 78; J. L. Barnard, 1960: 271 (as *Paraphoxus*); pereopod 3 not thin (to a new genus to be described)
*Paraphoxus similis* J. L. Barnard, 1960: 230
*Paraphoxus spinosus* Holmes, 1905: 477; J. L. Barnard, 1960: 243
2. Wrist of gnathopod 2 not shortened; setae on article 2 of antenna 1 set apically (and telson with lateral setae). *Parharpinia sinuata* K. H. Barnard, 1932: 103

II. Peduncle of uropod 1 lacking special spine.
A. Articles 4–5 of pereopods 5–6 stout, facial spines on article 4 of antenna 2 in 2 or more rows.
1. Epimera 1–2 with posterior setae, telson with supernumerary dorsal setation.
*Pontharpinia milleri* Thorsteinson, 1941: 82; J. L. Barnard, 1960: 266 (as *Paraphoxus*); *Pontharpinia robusta* Gurjanova, 1938: 262
*Pontharpinia obtusidens* Alderman, 1936: 54; J. L. Barnard, 1960: 249 (as *Paraphoxus*); *Pararpinia* [sic] *pontarpioides* Gurjanova, 1953: 229
2. Epimera 1–2 lacking long posterior setae, telson lacking supernumerary dorsal setation.
a. Gnathopods with mitelloid hands, thin and/or highly setose anteriorly.
*Paraphoxus abronius* J. L. Barnard, 1960: 203
*Paraphoxus bicuspidatus* J. L. Barnard, 1960: 218
*Paraphoxus fatigans* J. L. Barnard, 1960: 209
*Pontharpinia tridentata* J. L. Barnard, 1954: 4; 1960: 261 (as *Paraphoxus*)
*Paraphoxus variatus* J. L. Barnard, 1960: 198
*Paraphoxus vigitegus* J. L. Barnard 1971: 70 (but urosome with spike)
b. Gnathopods ordinary, hands ovatorectangular, poorly setose anteriorly.
*Paraphoxus daboius* J. L. Barnard, 1960: 210
*Paraphoxus heterocuspidatus* J. L. Barnard, 1960: 224
*Pontharpinia rostrata* Dana of Pirlot, 1932: 62
*Paraphoxus stenodes* J. L. Barnard, 1960: 211

B. Articles 4–5 of pereopods 5–6 thin, facial spines on article 4 of antenna 2 mostly confined to one row.
   1. Wrists of gnathopods elongate, ventral setae on article 2 of antenna 1 widely spread.
      *Parharpinia calcarata* Gurjanova, 1938: 272; J. L. Barnard, 1960: 238 (as *Paraphoxus*)
      *Paraphoxus robustus* Holmes, 1908: 618; J. L. Barnard, 1960: 235
      *Paraphoxus subuncigerus* Kudrjaschov, 1965: 1776
   2. Wrists of gnathopods short, ventral setae on article 2 of antenna 1 confined apically.
      *Pontharpinia uncinata* Chevreux, 1912: 100

### List of Species Rejected from *Paraphoxus*

*Protophoxus australis* K. H. Barnard, 1930: 335 (to *Protophoxus*)
*Phoxus batei* Haswell, 1879: 259 (to *Birubius*)
*Trichophoxus capillatus* K. H. Barnard, 1930: 336 (to *Trichophoxus*)
*Metaharpinia cornuta* Schellenberg, 1931: 68 (to *Metharpinia*)
*Metharpinia longirostris* Schellenberg, 1931: 65 (to *Metharpinia*)
*Urothoe pinguis* Haswell, 1879a: 325 (to *Pontharpinia*)
*Paraphoxus rakiura* Cooper and Fincham, 1974 (should be established in a new genus)
*Paraphoxus stebbingi* J. L. Barnard, 1958: 148 (to a new genus to be described)
*Paraphoxus tattersalli* J. L. Barnard, 1958: 148; 1960: 282 (to a new genus to be described)
*Phoxus villosus* Haswell, 1879: 258 (to *Parharpinia*)
*Paraphoxus waipiro* J. L. Barnard, 1972: 143 (to a new genus to be described)
*Paraphoxus* sp. Australia, J. L. Barnard, 1960: 285 (to a new genus to be described)

### List of Unclear Species of "*Paraphoxus*"

*Pontharpinia barnardi* Pirlot, 1932: 62; for *P. rostrata* of K. H. Barnard, 1931:119 [not Dana, 1853]; pereopod 5 and epimeron 3 unusual
*Pontharpinia centralis* Schellenberg, 1938: 15; pereopods 5–6 thin
*Pontharpinia maxima* Stephensen, 1947: 42; possibly close to *P. pyripes*; uropod 1 with ventral peduncular setae
*Pontarpinia* [sic] *nasuta* Gurjanova, 1936: 249; 1951: 382
*Parharpinia obliqua* K. H. Barnard, 1932: 101; probably similar to new genus of paraphoxin from Australia to include *P. tattersalli*, new genus, to be established by Barnard and Drummond (in prep.)
*Pararpinia* [sic] *ochotica* Gurjanova, 1953: 225
*Paraphoxus pyripes* K. H. Barnard, 1930: 332; perhaps similar to *P. maxima* but gnathopod 2 probably enlarged

*Parharpinia rotundifrons* K. H. Barnard, 1932: 104; ?Stephensen, 1947: 44; gnathopods probably like basic Australian genus as cited above under *P. obliqua*

*Parharpinia uncigera* Gurjanova, 1938: 267; 1951: 388; pereopods 5–6 thin, article 4 of antenna 2 stunted, possibly article 6 of pereopods 3–4 lacking posterior spines.

### *Pontharpinia* Stebbing

*Pontharpinia* Stebbing, 1897: 32–33.

*Diagnosis of female [adult male unkown]*: Eyes present; flagella of antennae 1–2 unreduced, fuzz on article 1 of antenna 1 unknown in male, article 2 of antenna 1 short, setae widely spread on ventral surface, calceoli on primary flagellum of male antennae unknown; antenna 2 with weak ensiform process, article 3 with groups of 5 + 1 facial setae; article 5 shortened; upper lip and epistome not strongly distinct from each other; right mandibular incisor with 3 teeth, molar fully triturative, small, cylindrical, right lacinia mobilis bifid, rami equal, bearing weak facial denticles, palpar hump of mandible of medium size; lower lip of mandible lacking cones; palp of maxilla 1 biarticulate, inner plate with 5 or more setae; inner plates of maxilliped ordinary, palp article 3 weakly protuberant, dactyl elongate, apical nail small, mostly immersed; gnathopod 1 small, gnathopod 2 enlarged, of diverse shapes, article 5 of gnathopod 2 greatly shortened, hands expanded, rectangular, poorly setose anteriorly, palms oblique; article 5 of pereopods 3–4 lacking posteroproximal setae, article 6 bearing normal 2 rows of spines, mid-distal armament composed of medium to small spine, dactyls bearing 1 inner tooth; article 2 of pereopod 5 of broad form and expanding distally, of pereopod 7 of ordinary phoxocephalid kind, article 3 of pereopod 7 small (ordinary), articles 4–5 of pereopods 5–6 broad, pereopod 7 of normal large size, article 2 ventrally setose; peduncular apices of uropods 1–2 not combed, peduncle of uropod 1 normally elongate, lacking ventral spike but bearing special large apico*medial* spine, other medial armaments widely spread, dorsal spines widely spread, inner ramus of uropod 1 bearing only one row of spines, peduncle of uropod 2 with medial spines widely spread, inner ramus spinose, as long as outer ramus, uropod 3 ordinary, article 2 of outer ramus with 3 apical setae and subapical lateral spine-seta; telson with only apical spines but each lobe with huge crescentic brush of setae midlaterally, other setules abnormal, one each confined dorsobasally on each lobe; urosomite 1 with ventral crescentic brush of setae; epimera 1–2 naked posteriorly, with all facial setae ventrally placed, epimeron 3 with midfacial setae.

*Description*: Rostrum large and ordinary; facial spines on article 4 of antenna 2 in 2 or more rows; article 5 thin; article 1 of mandibular palp short, palp of medium thickness but huge in comparison to mandibular body; outer plate of maxilla 1 with 11 spines, one spine especially thickened; setation of maxilla 2 ordinary; coxae 2–4 lacking antero-

dorsal humps; article 5 of gnathopod 2 cryptic (posterior margin concealed by articles 4 and 6); article 2 of pereopod 7 with small posterior teeth, bearing numerous groups of facial setae; gills present on pereonites 2–7.

*Type-species*: *Urothoe pinguis* Haswell, 1879a (monotypy).

*Relationship*: The genus and its unique species may be the most primitive living phoxocephalid in the present context of this family (assuming full rostral development as a prerequisite or barring other discoveries). Like *Phoxocephalus* and *Leptophoxoides* it bears a fully triturative mandibular molar, a character assumed to be primitive, short article 2 of antenna 1, and an enlarged gnathopod 2, but unlike the more advanced *Phoxocephalus* and *Leptophoxoides* it has a higher number of setae on the inner plate of maxilla 1, continuously spinose rami on uropods 1–2 and facial setae on article 2 of pereopod 7, all characters which might be marks of relationship to gammaroid-haustorioid ancestors. Nevertheless *Pontharpinia* obviously is a very advanced taxon of amphipod in that it has specializations that must remove it from the direct ancestral pool of other phoxocephalids. Its primitiveness is simply a hypothetical assessment; it has never lost certain marks of its ancestors which we consider are weak character linkages to an ancestral stream of species.

*Pontharpinia pinguis* retains many of the characters lost in various degrees in other genera of phoxocephalids, such as: special spine on peduncle of uropod 1, enlarged gnathopod 2, short and cryptic article 5 of gnathopod 2, dispersed facial setae on article 3 of palp on maxilliped, full rostrum, facial setae on pereopod 7, triturative molar, ensiform antenna 2, fully setose maxilla 2, widely setose inner plate of maxilla 1, inner tooth on dactyls of pereopods, broad articles on pereopods 5–6, posterior setae on article 2 of pereopods 5–6, posterior setae on coxa 4, anterior setae on coxa 1, setal brushes on telson, fully flabellate right lacinia mobilis, setose dactyl of pereopod 7, ventrally spread setae on article 2 of antenna 1, continuously spinose rami of uropods 1–2, widely spread ventral setation on epimera 1–2, mainfold setae on article 2 of outer ramus on uropod 3, facial setae on epimeron 3, ventral setae on urosomite 1, subapical setae on peduncle of uropod 3, and lateral setosity on palp article 2 of mandible.

*Pontharpinia pinguis*, however, has the following characters about which we are unable to confirm the degree of primitiveness; absence of basofacial setae on uropod 1, absence of double spine rows on the inner ramus of uropod 1, absence of lateral spination on the urosome, *short and immersed apical nail on palp article 4 of the maxilliped, unequal flagella on antenna 1, absence of thick apical spines on the inner plates of the maxillipeds, presence of only one (not 2) dorsolateral setule on each lobe of the telson, absence of anterodorsal humps on coxae 1–4, absence of facial setae on coxae 6–7, absence of posteroproximal setae on article 5 of pereopods 3–4, *absence of cones on the lower lip, almost fully amalgamated upper lip and epistome and multiple sets of spines

on article 4 of antenna 2. Except for the two characters marked by asterisks we believe all others are advancements in phoxocephalid evolution.

### *Parharpinia* Stebbing

*Parharpinia* Stebbing, 1899: 207; 1906: 147.

*Diagnosis of male and female*: Eyes present; flagella of antennae 1–2 unreduced, article 1 of antenna 1 bearing medial fuzz in male, article 2 short, setae widely spread on ventral surface, primary flagellum lacking calceoli in male (as far as known); antenna 2 lacking ensiform process, article 3 with only 2 facial setules, article 5 not shortened, lacking calceoli in male (as far as known), flagellum also lacking calceoli; upper lip and epistome not strongly distinct from each other; right mandibular incisor with 3 teeth, molar not triturative, small, forming pillow-shaped boss, bearing small articulate spines, fuzz weak to absent, right lacinia mobilis bifid, rami unequal, bearing facial denticles, palpar hump of mandible of medium size; lower lip bearing cones; palp of maxilla 1 biarticulate, inner plate with 4 setae; inner plates of maxilliped ordinary, palp article 3 weakly protuberant, dactyl elongate, apical nail of medium size, mostly immersed; gnathopods small, almost identical in shape but article 5 of gnathopod 2 slightly shortened, hands ovate-rectangular, poorly setose anteriorly, palms oblique; article 5 of pereopods 3–4 bearing posteroproximal setae, article 6 bearing normal 2 rows of spines, middistal armament composed of small to medium spine or thick short seta, dactyls bearing one inner tooth; article 2 of pereopod 5 of broad form but tapering distally, of pereopod 7 of ordinary phoxocephalid kind, article 3 of pereopod 7 small (ordinary), article 4–5 of pereopods 5–6 narrow, pereopod 7 of normal large size, article 2 ventrally setose; peduncular apices of uropods 1–2 not combed, peduncle of uropod 1 normally elongate, lacking ventral spike but bearing special large apico-*medial* spine, other medial spines widely spread, dorsal spines mainly apical, inner ramus of uropod 1 bearing only 1 row of spines, peduncle of uropod 2 with only 1 medial spine (spinule) set apically, inner ramus naked, as long as outer ramus, uropod 3 ordinary, article 2 of outer ramus with 2–4 setae (variable infraspecifically); telson variable in spination, with either or both lateral and dorsal spines, midlateral setules normal, placed at about mark 33, comprising a pair on each side; urosomite 1 devoid of major lateral spines and ventral setae except for distal setae at base of uropod 1; epimera 1–3 with posterior setae, epimera 1–2 with facial setae all ventral, epimeron 3 with few midfacial setae or spines.

*Description*: Rostrum large and ordinary; facial spines on article 4 of antenna 2 primarily in one row scarcely divided into sections, article 5 thick; article 1 of mandibular palp short, palp thin; outer plate of maxilla 1 with 11 spines, one spine especially thickened; setation of maxilla 2 ordinary; inner and outer plates of maxilliped ordinary; coxae

2–4 with very weak anterodorsal humps; article 5 of gnathopods free (not cryptic); article 2 of pereopod 7 with small posterior teeth, lacking facial setae; gills present on pereonites 2–7.

*Type-species*: *Phoxus villosus* Haswell, 1879 (original designation).

*Remarks on type-species*: Stebbing (1899) designated *Phoxus villosus* as type of his *Parharpinia* but confounded the generic establishment because he did not have *Phoxus villosus* in hand. He probably had *Protophoxus australis* K. H. Barnard in hand as evidenced by his statement that he had a specimen of *Phoxus batei* Haswell as identified by G. M. Thomson, an entity confirmed by Hurley (1954) to be *Protophoxus australis*. The diagnosis was not affected by this confusion because the diagnosis was so brief that it did not touch upon differences between *Protophoxus* and *Parharpinia*.

*Composition*: The type-species and one new species to be described by Barnard and Drummond (in prep.) from Australia.

*Relationship*: *Parharpinia* differs from *Paraphoxus* Sars in the presence of dorsal-lateral spines on the telson; in *Paraphoxus* any telsonic spines are always fully apical. *Parharpinia* also bears a special, enlarged medial spine on the peduncle of uropod 1 and has posteriorly setose epimera 1–2. The apical nail on palp article 4 of the maxilliped is more strongly immersed than in species of *Birubius*. *Protophoxus* K. H. Barnard resembles *Paraphoxus* in the absence of posterior setae on epimera 1–2 but the special spine on the peduncle of uropod 1 is fully lateral instead of being fully medial as in *Parharpinia*. Both *Protophoxus* and *Parharpinia* have article 3 of pereopod 5 tapering distally. The telsonic spination in *Protophoxus* is more consistently dorsal than in *Parharpinia*, the latter having a highly variable placement of dorsal and lateral elements often so flexible as to be termed setae; this variability is infraspecific. *Protophoxus* resembles *Paraphoxus* in the absence of long ventral setae on article 2 of pereopod 7 but *Parharpinia* has those setae fully developed.

*Parharpinia* differs from *Birubius* in the dorsal telsonic setospination, in the presence of the special spine on uropod 1, in the presence of posterior setation on epimera 1–2, and in the taper of article 2 on pereopod 5.

### *Protophoxus* K. H. Barnard

*Protophoxus* K. H. Barnard, 1930: 335.

*Diagnosis of male*: Eyes present; flagella of antennae 1–2 unreduced (in male), article 1 of antenna 1 bearing medial fuzz, article 2 short, setae widely spread on ventral surface, primary flagellum with calceoli; antenna 2 lacking ensiform process, article 3 with only 2 facial setules, article 5 not shortened, bearing dorsal calceoli, flagellum with calceoli; upper lip and epistome not strongly distinct from each other; right mandibular incisor with 3 teeth, molar not triturative, small, forming pillow-shaped boss, bearing small articulate spines and fuzz, right lacinia mobilis

bifid, branches unequal, bearing facial denticles, palpar hump of mandible of medium size; lower lip bearing cones; palp of maxilla 1 biarticulate, inner plate with 4 setae; inner plates of maxilliped ordinary, palp article 3 unprotuberant, dactyl elongate, apical nail of medium size, distinct, not deeply immersed; gnathopods small, almost identical in shape but article 5 of gnathopod 2 slightly shortened, hand ordinary ovatorectangular, poorly setose anteriorly, palms oblique; article 5 of pereopods 3–4 bearing posteroproximal setae, article 6 bearing normal 2 rows of spines, middistal armament composed of medium spine, dactyls bearing one inner tooth; article 2 of pereopod 5 of broad form but tapering distally, of pereopod 7 of ordinary phoxocephalid kind, article 3 of pereopod 7 small (ordinary), articles 4–5 of pereopods 5–6 narrow, pereopod 7 of normal large size, article 2 ventrally naked (lacking long setae); peduncular apices of uropods 1–2 naked and weakly combed respectively, peduncle of uropod 1 normally elongate, lacking ventral spike but bearing special large apico*lateral* spine, medial spines widely spread, dorsal spines widely spread, inner ramus of uropod 1 bearing only 1 row of spines, peduncle of uropod 2 with only 1 medial spine set apically, inner ramus spinose, as long as outer ramus, uropod 3 especially elongate, article 2 of outer ramus with only 2 apical setae; telson naked laterally, bearing dorsal spines, midlateral setules normal, placed at about mark 33, comprised of a pair on each side; urosomite 1 devoid of major lateral spines and ventral setae; epimera 1–2 lacking posterior setae, with facial setae located ventrally, none in midface, epimeron 3 lacking posterior setae, with midfacial setae or spines.

*Description*: Rostrum large and ordinary; facial spines on article 4 of antenna 2 primarily in 1 row scarcely divided into sections, article 5 thick; article 1 of mandibular palp short, apex of article 3 obliquely truncate, palp thin; outer plate of maxilla 1 with 11 spines, 1 spine especially thickened; setation of maxilla 2 ordinary; inner and outer plates of maxilliped ordinary; coxae 2–4 lacking anterodorsal humps; article 5 of gnathopods free (not cryptic); article 2 of pereopod 7 with small posterior teeth, lacking facial setae; gills present on pereonites 2–7.

*Type-species*: *Protophoxus australis* K. H. Barnard, 1930 (monotypy).

*Relationship*: This genus is now known to resemble *Parharpinia* Stebbing and to be distinguished from *Paraphoxus* Sars and *Birubius* in the following characters: (1) presence of dorsal spination on the telson; (2) presence of a special spine on the peduncle of uropod 1 and (3) strong taper on article 2 of pereopod 5. *Protophoxus*, however, differs from *Parharpinia* in: (1) the shift of the special spine on uropod 1 onto the full lateral side of the peduncle, whereas in *Parharpinia* that spine is fully medial; (2) the absence of posterior setation on epimera 1–3; (3) the absence of strong ventral setation on article 2 of pereopod 7.

*Protophoxus* and *Parharpinia* also have thin articles 4–5 on pereopods 5–6 but this character is almost evenly intergraded with some of the thin-membered species of *Birubius*.

*Protophoxus australis* K. H. Barnard
Figure 4 (part)

*Phoxus batei*.—Thomson, 1882: 232–233, pl. 17, fig. 2 (not Haswell).
*Protophoxus australis* K. H. Barnard, 1930: 335–336, fig. 12.
*Pontharpinia australis*.—Hurley, 1954: 581–587, figs. 1–28.

*Material*: Terra Nova 135, British Museum (Natural History) No. 1930.8.1:133–137, 8 specimens, 7 in alcohol, 1 mounted on 3 slides; 2 of these are juveniles or very young males as stated by K. H. Barnard, the other 6 are males, none is a female as stated by K. H. Barnard; 1 of the specimens in alcohol resembles female in some respects but detached head is male-like and carcass bears penial processes.

*Remarks*: The depiction of this species by Hurley (1954) is excellent; all of the details of the generic diagnosis and description given above have been checked and confirmed on the material in hand. Hurley pointed out that his specimen from Cook Strait had only 1 dorsal spine on each lobe of the telson whereas K. H. Barnard showed 5. K. H. Barnard, however, noted specimens from Terra Nova 106 that lacked these spines. We have not seen these but would suspect their identity on that basis. The smallest specimens, 3.5–4.0 mm, in the sample on hand, have 2 spines on each lobe; the largest whole specimen, about 6.5 mm, has 3 on each lobe; K. H. Barnard shows the apical telsonic spination to be composed of 2 short spines separated by a setule; the specimen in hand mounted on slides bears 3 spines on each lobe, 2 outer spines separated by the setule from the inner third spine. We estimate such variables to be normal from our study of Australian phoxocephalids. Hurley's specimen may, however, represent a Cook Strait race of the species.

We append figures of the right lacinia mobilis and uropod 1 from the slide-mounted specimen (size unknown, carcass missing). Inner plate of maxilla 1 of medium size, bearing long middle subapical pluseta, 1 shorter medioapical pluseta and 2 even smaller, almost naked, weakly lateral setae.

*Trichophoxus* K. H. Barnard

*Trichophoxus* K. H. Barnard, 1930: 336.

*Diagnosis of male*: Eyes present; flagella of antennae 1–2 unreduced (in male), article 1 of peduncle on antenna 1 lacking medial male fuzz, article 2 elongate, setae spread widely on ventral surface, primary flagellum with calceoli; antenna 2 with weak ensiform process, article 3 with numerous facial setae, upwards of 15, article 5 shortened, bearing dorsal calceoli, flagellum with calceoli; upper lip and epistome strongly distinct; right mandibular incisor with 4 teeth, molar not triturative, long, massive, conical, bearing 4 enlarged but strongly fixed spines, right lacinia mobilis bifid, rami subequal, bearing facial denticles, palpar hump of mandible small; lower lip lacking cones; palp of maxilla 1 biarticulate,

inner plate with 4 setae; inner plates of maxilliped ordinary, palp article 3 unprotuberant, dactyl elongate, apical nail short and fully immersed or fused; gnathopods small, gnathopod 2 slightly smaller than gnathopod 1, almost identical in shape, wrists elongate, hands thin, mitelloid, heavily setose anteriorly, palms transverse; article 5 of pereopods 3–4 lacking posteroproximal setae, article 6 bearing normal 2 rows of spines, mid-distal armament comprising huge spine, dactyls bearing 1 inner tooth; article 2 of pereopod 5 of broad form, nontapering, of pereopod 7 extended-nasiform, article 3 of pereopod 7 greatly enlarged, articles 4–5 of pereopods 5–6 very broad, pereopod 7 miniaturized; article 2 ventrally setose; peduncular apices of uropods 1–2 weakly combed, peduncle of uropod 1 normally elongate, bearing weak ventral spike, medial spine(s) confined to apical end, dorsal spines fully spread, inner ramus of uropod 1 bearing only 1 row of spines, peduncle of uropod 2 with more than 1 medial spine, inner ramus naked but as long as outer ramus, uropod 3 especially elongate and article 2 of outer ramus probably with 3 apical setae; telson with lateral spines, lateral setules reduced to 1 on each side and shifted highly distad; urosomite 1 with 2 rows of lateral spines, 1 ventral crescent of setae; epimera 1–2 with both posterior and midfacial setae.

*Description*: Rostrum very small; facial spines on article 4 of antenna 2 in 2 or more main rows, article 5 thin; article 1 of mandibular palp short, apex of article 3 obliquely truncate, palp of medium thickness; outer plate of maxilla 1 with 11 spines, 1 spine especially thickened; setation of maxilla 2 ordinary; inner and outer plates of maxilliped ordinary; coxae 2 and 4 with anterodorsal humps; article 5 of gnathopods free (not cryptic); article 2 of pereopod 7 with small posterior teeth, bearing facial setae; gills present only on pereonites 2–6.

*Type-species*: *Trichophoxus capillatus* K. H. Barnard, 1930 (monotypy).

*Relationship*: This genus is now known to be distinguished by numerous characters separating it from *Paraphoxus* Sars to which it was relegated by J. L. Barnard (1960). We have compared it with 38 species of *Birubius*, the basic genus from Australia, and 20 other species of various genera from the northern Pacific Ocean. *Trichophoxus* has its closest relationships to a new genus (genus of 5 species, Barnard and Drummond, in prep.) from Australia. These 2 genera are characterized by the following attributes: (1) the semitriturative molar, enlarged, bearing 4 enlarged poorly articulate spines similar to teeth; (2) the miniaturized pereopod 7 with enlarged article 3; (3) the weakly ensiform process on antenna 2; (4) manifold setation of article 3 on antenna 2; (5) naked posteroproximal margin on article 5 of pereopods 3–4; (6) absence of medial fuzz in males on article 1 of antenna 1; (7) strong distinction between upper lip and epistome; (8) absence of cones on lower lip; (9) poorly developed apical nail on palp article 4 of maxilliped; (10) anterodorsal humps on coxae 2–4; (11) ventral spike on peduncle of uropod 1; (12) presence of 3 (not 2) apical setae on article

2 of outer ramus on uropod 3; and (13) patchwork (in contrast to single row) of denticles on each lobe of male telson.

*Trichophoxus* is distinguished from the new Australian genus comprising 5 species in numerous characters to be discussed by Barnard and Drummond (in prep.), but a few are given here so as to justify the necessarily long generic diagnosis: (1) lateral spination on urosome; (2) lateral spination on telson; (3) far more numerous setae on article 3 of antenna 2; (4) presence of 4 setae (not 3) on inner plate of maxilla 1; (5) immensity of apical midspine on article 6 of pereopods 3–4; (6) elongation and bareness of inner ramus on uropod 2; (7) normally elongate peduncle of uropod 1; (8) proximal spination on peduncle of uropod 1; (9) presence of only 1 row of spines on inner ramus of uropod 1; (10) presence of only 1 ventral crescent of setae on urosomite 1; (11) strong distal shift of and reduction in number of dorsal setules on telson; (12) absence of any combs on pereopods 5–7; (13) presence of facial humps on right lacinia mobilis; (14) distad shift in primary tooth on dactyls of pereopods 3–4; (15) presence of more than 1 medial spine on peduncle of uropod 2.

In many ways *Trichophoxus* is more primitive than the diverse Australian genus in such characters as peduncles of uropods 1–2 and lack of pereopodal combs but is far more specialized than the Australian genus in telsonic and urosomal ornamentation.

*Trichophoxus*, our unnamed new Australian genus, and the genus to which *Paraphoxus rakiura* Cooper and Fincham, 1974, should be relegated (new), have numerous affinities as marked by mandibular molar, coxal humps, article 3 of antenna 2, ensiform process of antenna 2, gnathopod form, setation pattern on article 5 of pereopods 3–4, prebuccal parts and the other characters noted above. *Paraphoxus rakiura* should be given a genus of its own, to differ from *Trichophoxus* in the presence of setae on the peduncle of uropod 1, the pattern of the various ornaments on uropods 1–2, and the giant tooth of epimeron 3 among others.

*Trichophoxus capillatus* K. H. Barnard
Figures 1–3, 4 (in part)

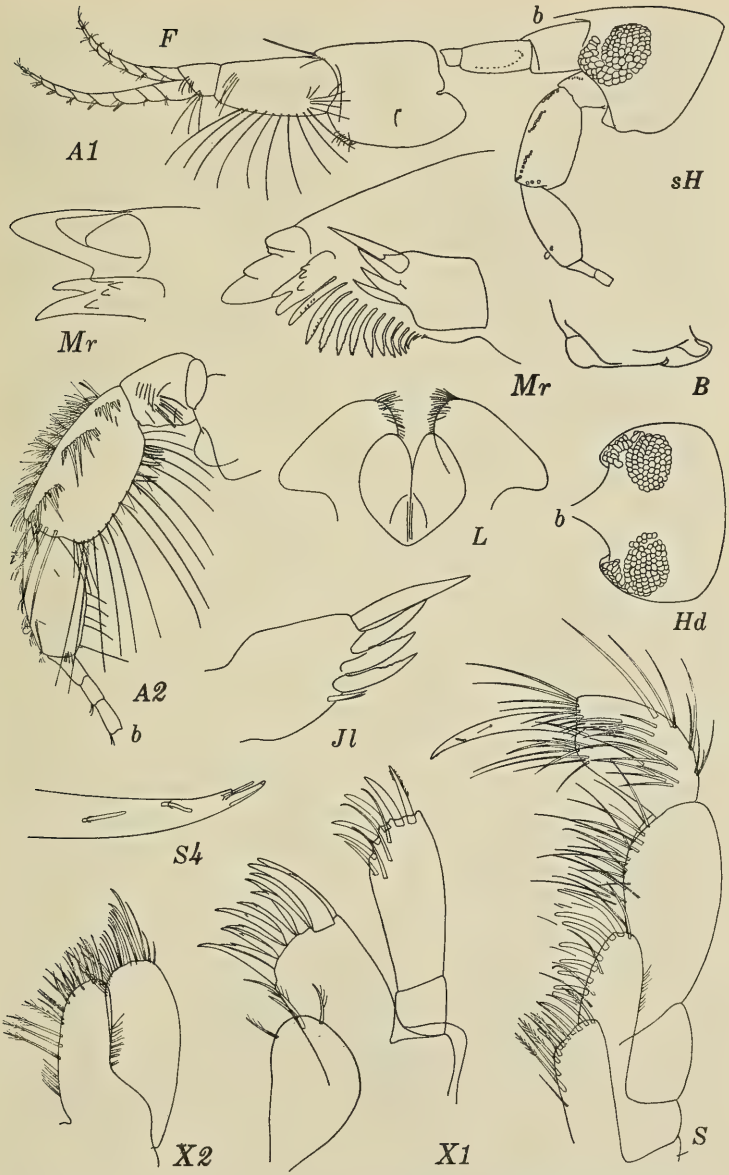
*Trichophoxus capillatus* K. H. Barnard, 1930: 336–337, fig. 13.

*Description of female*: Head (broken) about 18+ percent of total body length, greatest width about 110 percent of length, rostrum constricted, narrow, short, exceeding middle of article 1 on antenna 1; eyes

---

→

Fig. 1. *Trichophoxus capillatus* K. H. Barnard, lectotype, male, 7.15 mm. A, antenna; B, prebuccal lateral; C, coxa; D, dactyl of pereopod; E, epimeron; F, accessory flagellum; G, gnathopod; H, head; I, inner ramus, J, molar; L, lower lip; M, mandible; O, outer ramus; P, pereopod; Q, cuticle; R, uropod, S, maxilliped; T, telson; U, upper lip; V, pleon;




W, palp; X, maxilla; Y, right lacinia mobilis; a, peduncle; b, broken; d, dorsal; e, enlarged; f, flagellum; i, medial; l, left; n, enlarged; r, right; s, setae removed; z = abnormal.

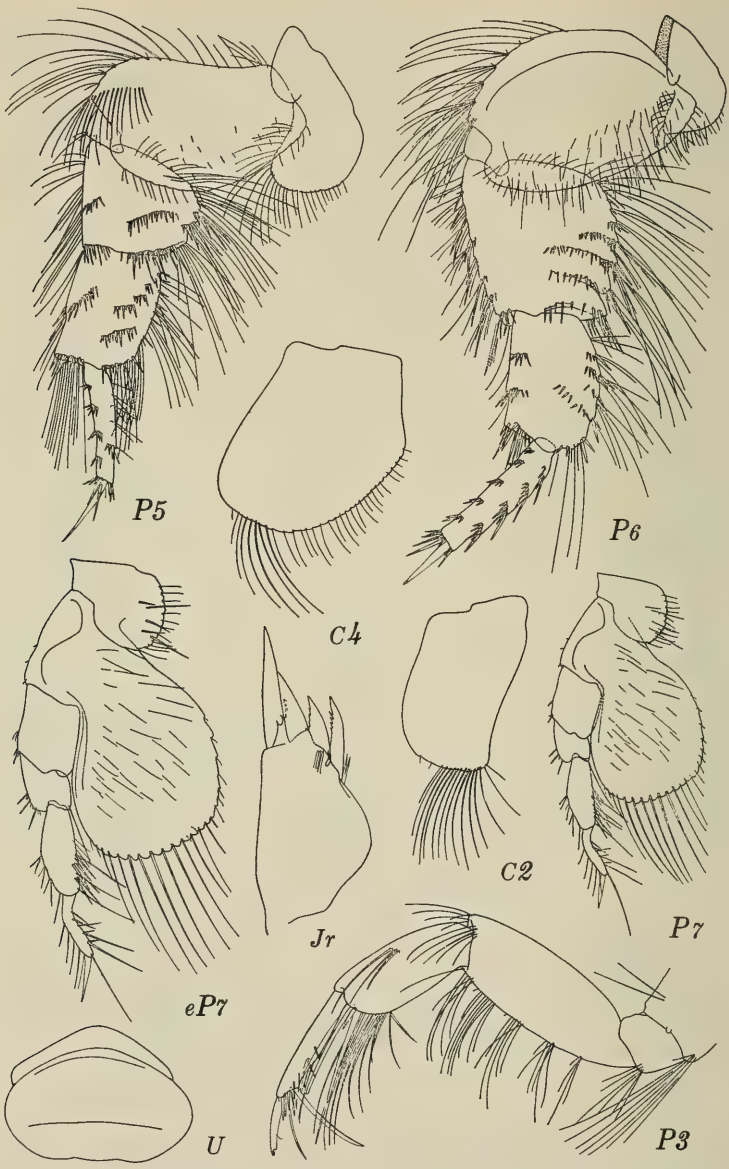



FIG. 2. *Trichophoxus capillatus* K. H. Barnard, lectotype, male, 7.15 mm. Symbols, see Fig. 1.

large, clear of occluding pigment; article 1 of peduncle on antenna 1 about 1.3 times as long as wide, about 1.9 times as wide as article 2, ventral margin with about 20 setules, strongly produced dorsal apex with 3 setules, article 2 about 0.85 times as long as article 1, with ventral crescent of 16 setae, primary flagellum with 9 articles, about 0.7 times as long as peduncle, bearing 1 long aesthetasc on articles 1–8, accessory flagellum with 8 articles; article 3 of antenna 2 with 17 facial setae, spine formula of article 4 = 4-11-11-7 or 4-11-11-6, dorsomedial margin fuzzy, ventral margin with 15 groups of 1–3 long to short setae, 3 ventrodistal setae and 4 dorsodistal spines, article 5 about 0.77 times as long as article 4, facial spine formula = one plus setule, dorsal margin bearing 7 sets of male setae and 1–2 calceoli, ventral margin with 5 sets of short setae, 4 ventrodistal setules, flagellum elongate, with 33 articles, one calceolus each on articles 4, 6, 8, . . . 28 (one side broken); mandibles with weak palpar hump, right incisor with 4 teeth, left incisor with 7 teeth in 2 groups, right lacinia mobilis bifid, distal branch little shorter than proximal, narrow, with 3 facial humps, proximal branch simple, pointed, left lacinia mobilis with 4 teeth, middle teeth weakly shortened, right rakers 12 plus 1 rudimentary, left rakers 11 plus 1 rudimentary, molar composed of elongate soft cones, each molar with 4 large spines, one spine enlarged, each molar with bifid setule, palp article 1 short, article 2 with 6 medium to short inner apical setae and 2 other shorter inner setae and 1 long outer seta, article 3 about as long as article 2, oblique apex with 10 spine-setae, 4 inner setae, basofacial formula = 3 or 2; inner plate of maxilla 1 ordinary, bearing 1 long apical pluseta, and 3 other much shorter setae, palp article 2 with 5 apical spines and 4 submarginal setae; inner plate of maxilla 2 shorter than outer, outer much broader than inner, without apicolateral setae, inner with 7 medial setae; inner plate of maxilliped with 2 large, thick apical spines, 6 apicofacial setae, 4 medial setae, outer plate with 11 medial and apical spines (not all in illustration), 1 apicolateral seta, palp articles 1–2 lacking apicolateral setae, medial margin of article 2 moderately setose, article 3 with 17 facial setae, 8 lateral setae, nail of article 4 fully immersed, with 3 accessory setules; coxa 1 scarcely expanded apically, anterior margin weakly convex, main ventral setae of coxae 1–4 = 11-15-15-32, posteriormost seta of coxae 1–3 shortened, anterior and posterior margins of coxa 4 weakly divergent, posterior margin oblique, convex, posterodorsal corner rounded, posterodorsal margin of ordinary length, almost straight, width-length ratio of coxa 4 = 4:5; long posterior setae on article 2 of pereopods 1–4 = 6-5-5-6, short posteriors = 0-2-0-0, long anteriors = (10–14)-12-3-27, short anteriors = 2-3-4-0, gnathopod 1 also with 4 facial setae; gnathopods with apically narrowed hands, especially on gnathopod 2, width ratios on articles 5–6 of gnathopods 1–2 = 30:26 and 27:25, length ratios = 61:46 and 64:46, palmar humps ordinary to small, respectively, palms transverse, article 5 of gnathopods elongate, ovate, posterior margin rounded-flat; pereopod 4 stouter than pereopod 3 especially on article 4, no margins with combs, facial setae formula on

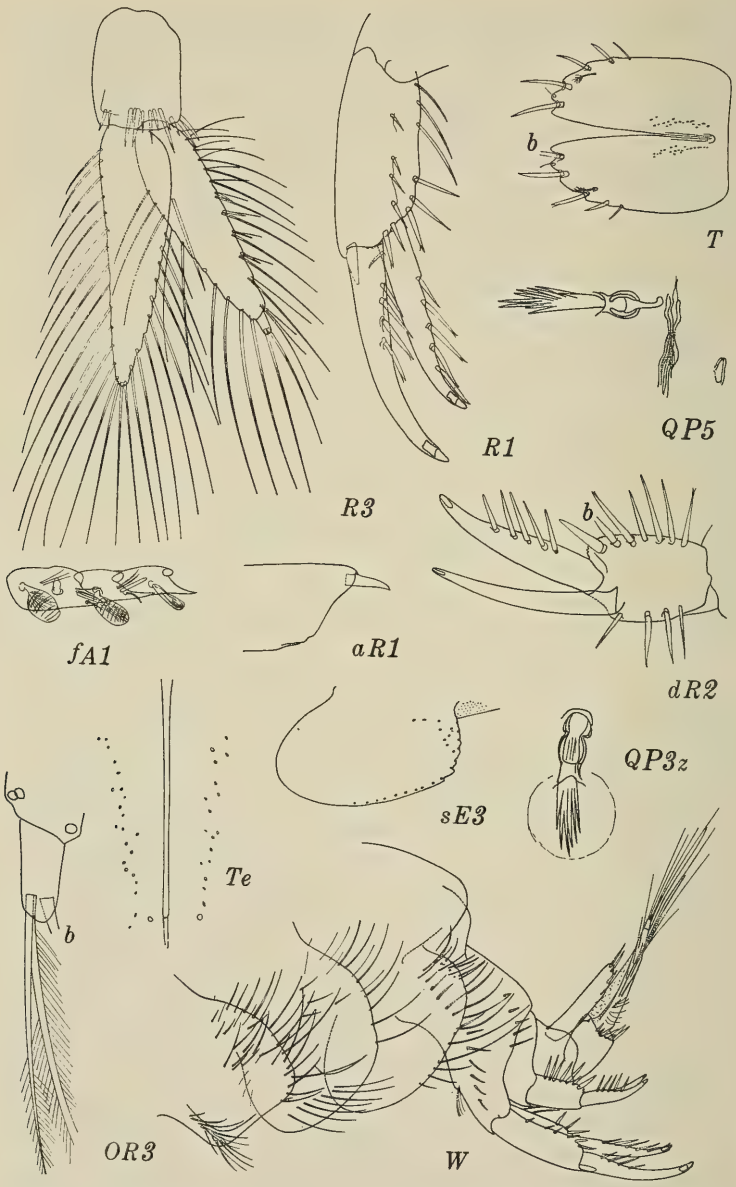



Fig. 3. *Trichophoxus capillatus* K. H. Barnard, lectotype, male, 7.15 mm. Symbols, see Fig. 1.

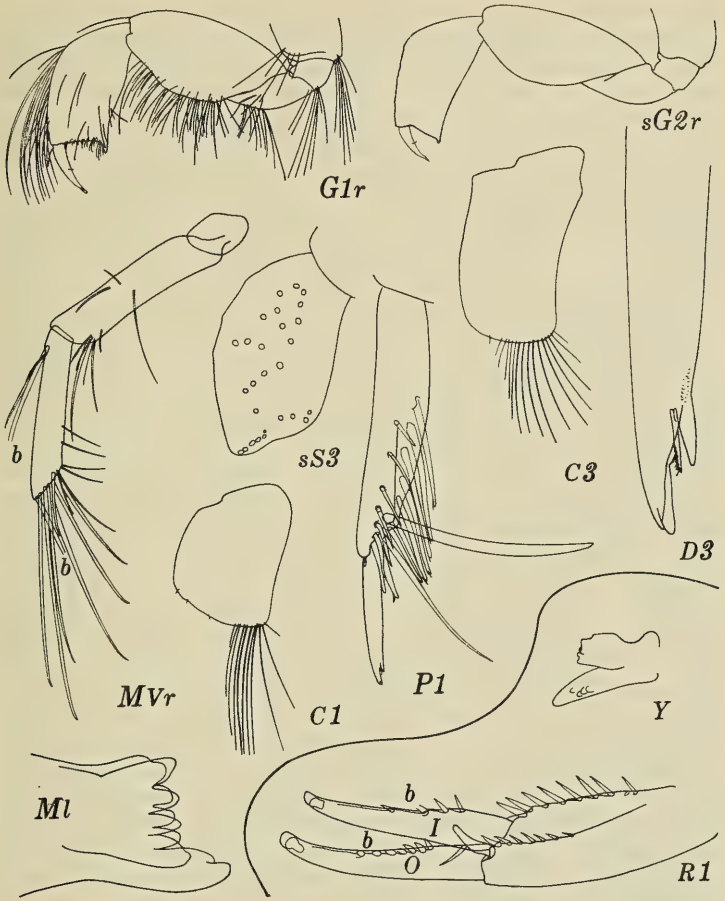



FIG. 4. *Trichophoxus capillatus* K. H. Barnard, lectotype, male 7.15 mm; lower box, *Protophoxus australis* K. H. Barnard, syntype, size unknown. Symbols, see Fig. 1.

article 4 = 5 and 6, on article 5 = 3 and 6, main spine of article 5 extending to M. 85 on article 6, spine formula of article 6 = 7 + 9 and 7 + 8 plus huge middistal spine, acclivity on inner margin of dactyls of pereopods 3–4 highly apicad, sharp, produced as tooth, emergent setule short, midfacial pluseta absent; coxae 6–7 with both facial and marginal setae; articles 4–5 of pereopods 5–6 broad, facial spine rows dense, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 of pereopod 5 = 48:44:33:10, of pereopod 6 = 58:

55 : 34 : 13, of pereopod 7 = 53 : 13 : 10 : 3, length ratios of pereopod 5 = 74 : 39 : 45 : 45, of pereopod 6 = 83 : 60 : 51 : 52, of pereopod 7 = 74: 15 : 27 : 19, article 2 of pereopod 7 reaching middle of article 5, with facial and ventral setae, no combs on pereopods 5–7; posteroventral corner of epimeron 1 rounded, posterior margin straight, setose, anteroventral margin with 12 medium setae, face with 16 short to medium setae, posteroventral corner of epimeron 2 rounded, weakly protuberant, posterior margin weakly convex, setose, ventral facial setae = 7, none set vertically, midfacial setae = 5, posteroventral corner of epimeron 3 rounded, weakly protuberant, with sinus, posterior margin short, weakly convex, serrate, setose, ventral margin with 9 setae, mainly in posterior half, face with several posterodorsal setae; rami of uropods 1–2 with fused apical nails, no ramus with accessory nails, outer ramus of uropod 1 with 4 proximal dorsal spines, apical margin naked, inner with 5 in single row only, outer ramus of uropod 2 with 5 dorsal spines, apical margin naked, inner with none, inner ramus as long as outer, peduncle of uropod 1 with 6 dorsolateral spines, medially with 6 marginal setae and spines, apicalmost an ordinary spine, ventrally with weak spike, peduncle of uropod 2 with 7 dorsal spines, medially with 4 spines, apicolateral corners of peduncles on uropods 1–2 with weak comb, none on rami; peduncle of uropod 3 with 12 ventral spines, dorsally with 1 lateral spinule, 2 medial spines, rami masculine, inner extending to M. 100+ on article 1 of outer ramus, apex with 2–3 (3 probably normal), setae, medial and lateral margins setose, article 2 of outer ramus short, 0.10 as long as article 1, bearing 2 long setae, medial margin of article 1 setose, lateral margin with 11–12 acclivities, spine formula = $0 \times 6$, $1 \times 3$, $0 \times 2$, or $0 \times 5$, 1, 0, 1, 1, 0, 1, 0, 0, setal formula = 1, $2 \times 10$, 3 or 1, 1, $2 \times 7$, 3, 2, 3, 3; telson weakly elongate, length-width ratio = 33 : 29, not fully cleft, each apex of medium width, undulate, lateral acclivity deep, with lateral and medial spines separated by setules, each lobe with 3 other lateral spines, midlateral setules shifted distad, one on each side, each lobe with irregular mediobasal denticle patch; urosomite 1 with ventral crescent of 10 setae, 2 lateral facial rows of 12 and 5 spines, articulation line complete, urosomite 1 weakly protuberant dorsally; cuticle with enlarged bulbar setules mixed with pipes, setules surrounded by clear spaces in midst of fine striations in form of linear fingerprint pattern, emergent setules long, branched.

*Observations and illustrations*: Rostrum broken; eyes slightly disassociated; mandibular molar pointing towards observer but flattened in whole view; all long setae of uropod 3 plumose, article 3 of antenna 2 also with 1 disjunct setule (ordinary phoxocephalid with only 2 facial setules highly disjunct, this species with groups of 17 and 1); telsonic denticles intermediate between linear row and broad patch; right uropod 3 of lectotype with only 2 apical setae, left with additional setule (we presume 3 is normal from our study of related new genera); maxilla 1 with only 11 spines on outer plate, outer spine with facial hump showing as twelfth projection.

*Lectotype*: British Museum (Natural History) No. 1930.8.1 : 142–144, male, 7.15 mm, from syntypes of K. H. Barnard (1930).

*Type-locality*: Terra Nova Station 135, New Zealand, North Cape, 1.ix.11, 3 meters, night.

**Birubius** Barnard and Drummond, new genus

*Diagnosis of male and female*: Eyes present; flagella of antennae 1–2 unreduced, article 1 of antenna 1 bearing medial fuzz in male, article 2 elongate, setae widely spread ventrally or fully ventral, primary flagellum with calceoli in male; antenna 2 lacking ensiform process, article 3 with only 2 facial setules, apicalmost usually elongate, article 5 not shortened (in standards based on Australian genera), bearing dorsal calceoli in male, flagellum with calceoli in male; upper lip and epistome scarcely distinct, often fully fused but recognizably with upper lip dominant; right mandibular incisor with 3 teeth, molar not triturative, medium to small, pillow-shaped, bearing 4 or more partially articulate spines, usually with fuzz (usually contained on a distinct plusetule), right lacinia mobilis bifid or simple, flabellate or thin, bearing or lacking denticulations and facial humps, palpar hump small to medium; lower lip bearing cones; palp of maxilla 1 biarticulate, inner plate with 4 setae (rarely 3); inner plates of maxilliped ordinary, strongly setose, palp article 3 scarcely or not protuberant, dactyl elongate, apical nail distinct, medium to elongate, not immersed; gnathopods small, similar in shape but article 5 of gnathopod 2 often shorter than on gnathopod 1, never cryptic, hands ovato-rectangular, poorly setose anteriorly, palms oblique; article 5 of pereopods 3–4 bearing setae posteroproximally, article 6 bearing normal 2 rows of spines, middistal spine or seta present, dactyls bearing inner tooth, apical nail weakly distinct or partly fused to body of dactyl; article 2 of pereopod 5 of broad form, untapering, of pereopod 7 of ordinary phoxocephalid kind, article 3 small (ordinary), articles 4–5 of pereopods 5–6 broad to narrow, pereopod 7 of normal size, article 2 ventrally naked or setose; peduncular apices of uropods 1–2 not combed, peduncle of uropod 1 normally elongate, lacking ventral spike or special spines, medial spines widely spread, dorsal spines confined apically, inner ramus of uropod 1 bearing only 1 row of spines, peduncle of uropod 2 with spines either widely spread or confined apically, inner ramus free and elongate; uropod 3 ordinary, article 2 of outer ramus with only 2 apical setae; telson naked laterally and dorsally except for normal pair of setules set about mark 33–45; urosomite 1 usually naked laterally (but occasionally with lateral setae); epimera 1–2 lacking posterior setae, with facial setae located ventrally, none in midface, epimeron 3 ordinary, various, often with facial, posterior and ventral setae, and teeth.

*Description*: Rostrum various, from ordinary to severely reduced and often narrowed from dorsal view; facial spines on article 4 of antenna 2 in 2 or more rows, article 5 broad; article 1 of mandibular palp either short or weakly elongate, apex of article 3 oblique, palp thin, distal

branch of right lacinia mobilis either flabellate or thin; outer plate of maxilla 1 with 9–11 spines, no inner seta, one spine especially thickened; setation of maxilla 2 ordinary; inner and outer plates of maxilliped ordinary; coxae 1–4 lacking anterodorsal humps; article 5 of gnathopod 2 free (not cryptic); article 2 of pereopod 7 with small posterior teeth, lacking facial setae; gills present on pereonites 2–7.

*Type-species*: *Birubius panamunus* Barnard and Drummond, new species.

*Composition*: The type-species and 37 other species to be described by Barnard and Drummond (in prep.).

*Relationship*: Externally, *Birubius* is difficult to separate from the *Paraphoxus* group of genera but all species have 4 or more spines on each molar of the mandible whereas the *Paraphoxus* group has only 3 spines characteristically clumped basally and rather elongate. The inner plate of maxilla 1 in *Birubius* bears 4 setae, rarely 3, whereas all members of the *Paraphoxus* group bear only 2 setae on the inner plate. *Birubius* has an elongate article 2 of antenna 1 and normal sized article 5 of antenna 2, whereas the *Paraphoxus* group has a short article 2 of antenna 1 and a reduced size of article 5 on antenna 2 (males and females differing in the overall size but each with the article reduced in comparison to each sex of *Birubius*).

*Birubius* differs from *Parharpinia* and *Protophoxus* in the absence of a special spine on the peduncle of uropod 1, in the absence of supernumerary dorsal spination and setation on the telson and in the elongate article 2 of antenna 1. New American genera of phoxocephalids will be distinguished from *Birubius* (in prep.)

**Birubius panamunus** Barnard and Drummond, new species

*Diagnosis*: *Birubius* with fully broadened rostrum; right lacinia mobilis bifid, apical branch flabellate, apically denticulate, proximal branch simple, pointed; coxa 4 with long ventral setae, anterior and posterior margins parallel; epimeron 3 with large posteroventral tooth, bearing oblique facial row of setae, bearing row of ventral setae, posterior margin naked; uropod 1 with basofacial setae, inner ramus with accessory spine adjacent to apical nail, each lobe of telson with 1 stout apical spine and attendant setule.

*Holotype*: National Museum of Victoria, female "h", 6.5 mm.

*Type-locality*: Port Phillip Bay Environmental Study Station 1266, 11 March 1971, Port Phillip Bay, Victoria, Australia, 8 m, fine sand.

*Remarks*: Only 3 of the 38 species in this genus, to be described by Barnard and Drummond (in prep.), have the combination of long setae on coxa 4 and accessory apical nail on the inner ramus of uropod 1. This species differs from the other 2 species in the parallel margins of coxa 4, the fully broadened rostrum and in the presence of a fully developed oblique row of setae on the lateral face of epimeron 3.

*Material*: 30 samples from 10 stations in Port Phillip Bay, 139 specimens.

*Distribution*: Australia, Victoria, Port Phillip Bay, 6–22 m, sand, silty sand, clay.

*Etymology*: *Birubius*, Latinized, masculine, from an Aboriginal word meaning "Southern Cross"; *panamunus*, Latinized, from an Aboriginal word meaning "ocean".

Acknowledgments

We thank Dr. Roger J. Lincoln of the British Museum of Natural History, Dr. D. J. G. Griffin of the Australian Museum and Dr. Torben Wolff of the Universitets Naturhistorisk Museum for their assistance in attempting to locate specimens. Dr. Thomas E. Bowman of the Smithonsian Institution and Dr. E. L. Bousfield of the National Museum of Canada kindly read the manuscript and offered helpful suggestions. Miss Carolyn L. Cox of Smithsonian Institution inked our drawings for publication. Charline M. Barnard checked references and supplied the Literature Cited.

Literature Cited

Alderman, A. L. 1936. Some new and little known amphipods of California. Univ. California Publ. Zool. 41:53–74, figs. 1–51.

Barnard, J. L. 1954. Marine Amphipoda of Oregon. Oregon State Monog., Stud. Zool. 8:1–103, pls. 1–33.

———. 1958. Index to the families, genera, and species of gammaridean Amphipoda (Crustacea). Allan Hancock Found. Pub. Occ. Pap. 19:1–145.

———. 1960. The amphipod family Phoxocephalidae in the eastern Pacific Ocean, with analyses of other species and notes for a revision of the family. Allan Hancock Pacific Expeds. 18:175–368, pls. 1–75.

———. 1963. Relationship of benthic Amphipoda to invertebrate communities of inshore sublittoral sands of southern California. Pacific Naturalist 3:437–467, figs. 1–7.

———. 1969. A biological survey of Bahia de Los Angeles, Gulf of California, Mexico. IV. Benthic Amphipoda. Trans. San Diego Soc. Nat. Hist. 15:175–228, figs. 1–30.

——— 1971. Gammaridean Amphipoda from a deep-sea transect off Oregon. Smithsonian Contr. Zool. 61:1–86, figs. 1–48.

———. 1972. Gammaridean Amphipoda of Australia, Part I. Smithsonian Contr. Zool. 103:1–333, figs. 1–194.

———. 1974. Gammaridean Amphipoda of Australia, Part II. Smithsonian Contr. Zool. 139:1–148, figs 1–83.

Barnard, K. H. 1930. Amphipoda. British Antarctic ("Terra Nova") Exped., 1910, Nat. Hist. Rep. 8:307–454, figs. 1–63.

———. 1931. Amphipoda. Great Barrier Reef Exped. 1928–1929, British Museum (Nat. Hist.), Sci. Rep. 4:111–135, figs. 1–4.

———. 1932. Amphipoda. Discovery Rep. 5:1–326, figs 1–174, pl. 1.

Chevreux, E. 1912. Amphipodes. Deuxième Expédition Antarctique Francaise (1908–1910) comandée par le Dr. Jean Charcot. Sci. Nat.: Doc. Sci.:79–186, figs. 1–62.

Cooper, R. D. and A. A. Fincham. 1974. New species of Haustoriidae, Phoxocephalidae, and Oedicerotidae (Crustacea: Amphipoda) from northern and southern New Zealand. Rec. Dominion Museum 8:159–179, figs. 1–13, tables 1 and 2.

Dana, J. D. 1853. Crustacea. Part II. U. S. Expl. Exped. 14:689–1618; atlas of 96 pls. [published in 1855].

Gurjanova, E. 1936. Neue Beiträge zur Fauna der Crustacea-Malacostraca des arktischen Gebietes. Zool. Anz. 113:245–255, figs. 1–5.

———. 1938. Amphipoda, Gammaroidea of Siaukhu Bay and Sudzukhe Bay (Japan Sea). Rep. Japan Sea Hydrobiol. Exped. Zool. Inst. Acad. Sci. USSR. in 1934, part 1; 241–404, figs. 1–59 (in Russian with English summary).

———. 1951. Bokoplavy morej SSSR i sopredel'nykh vod (Amphipoda-Gammaridea). Akad. Nauk SSSR, Opredel. po Faune SSSR, 41:1–1029, figs. 1–705.

———. 1953. Novye dopolnenijka k dal'nevostochnoi fauna morskik bokoplavov. Trudy Zool. Inst., Akad. Nauk SSSR 13:216–241, figs. 1–19 (in Russian).

Haswell, W. A. 1879a. On Australian Amphipoda. Proc. Linn. Soc. New South Wales 4:245–279, pls. 7–12.

———. 1879b. On some additional new genera and species of amphipodous crustaceans. Proc. Linn. Soc. New South Wales 4:319–350, pls. 18–24.

Holmes, S. J. 1905. The Amphipoda of southern New England. U.S. Bureau Fisheries, Bull. 24:459–529, pls. 1–13.

———. 1908. The amphipods collected by the U.S. Bureau of Fisheries Steamer, "Albatross," off the west coast of North America, in 1903 and 1904, with descriptions of a new family and several new genera and species. U.S. Nat. Mus. Proc. 35:489–543, figs. 1–46.

Hurley, D. E. 1954. Studies on the New Zealand amphipodan fauna no. 3. The family Phoxocephalidae. Trans. Roy. Soc. New Zealand 81:579–599, figs. 1–5.

Kudrjaschov, V. A. 1965. Novye vidy bokoplavov (Amphipoda, Gammaridea) iz vostochnoi chasti Oxotskogo Morja. Zool. Zhur., Akad. Nauk SSSR 44:1776–1789, figs. 1–10.

Pirlot, J. M. 1932. Les amphipodes de l'expédition du Siboga. Deuxième partie. Les amphipodes gammarides. I.-Les amphipodes fouisseurs. Phoxocephalidae, Oedicerotidae. Siboga-Exped. Mon. 33b:57–113, figs. 12–34.

Sars, G. O. 1879. Crustacea et Pycnogonida nova in itinere 2do et 3tio Expeditionis Norvegicae anno 1877 & 78 Collecta. (Pro-

dromus descriptionis). Archiv Mathematik og Naturvidenskab, Kristiania 4:427–476.

———. 1895. Amphipoda. An Account of the Crustacea of Norway with Short Descriptions and Figures of All the Species 1:i–viii, 1–711, pls. 1–240, suppl. pls. 1–8.

SCHELLENBERG, A. 1931. Gammariden und Caprelliden des Magellangebietes, Südgeorgiens und der Westantarktis. Further Zool. Res. Swedish Antarctic Exped. 1901–1903, 2(6):1–290, figs. 1–136, pl. 1.

———. 1938. Litorale Amphipoden des tropischen Pazifiks. Kungl. Svenska Vetenskapsakad. Handl. 16(3):1–105, figs. 1–48.

SHOEMAKER, C. R. 1933. Amphipoda from Florida and the West Indies. American Mus. Novitates 598:1–24, figs. 1–13.

STEBBING, T. R. R. 1897. Amphipoda from the Copenhagen Museum and other sources. Trans. Linn. Soc. London, Zool. (2)7:23–45, pls 6–14.

———. 1899. Revision of Amphipoda (continued). Ann. Mag. Nat. Hist. (7)4:205–211.

———. 1906. Amphipoda, I: Gammaridea. Das Tierreich 21:1–806, figs. 1–127.

STEPHENSEN, K. 1947. Tanaidacea, Isopoda, Amphipoda, and Pycnogonida. Norske Videnskaps-Akad. Oslo, Sci. Res. Norwegian Antarctic Exped. 1927–28, 27:1–90, figs. 1–26.

THOMSON, G. M. 1882. Additions to the crustacean fauna of New Zealand. Trans. Proc. New Zealand Inst. 14:230–238, pls. 17, 18.

THORSTEINSON, E. D. 1941. New or noteworthy amphipods from the north Pacific coast. Univ. Washington Publ. Oceanogr. 4:50–96, pls. 1–8.

# INDEX TO NEW TAXA

VOLUME 88

(New taxa indicated in **boldface**; n. c. = new combination)


PHANEROGAMAE

GOODENIACEAE

Scaevola Taccada **Bryanii** ..... 75
Taccada Fauriei n. c. ..... 74

PLATYHELMINTHES

TURBELLARIA

Dugesia **arizonensis** ..... 113

MOLLUSCA

CEPHALOPODA

Graneledone **antarctica** ..... 448
**macrotyla** ..... 454

ANNELIDA

OLIGOCHAETA

**Agrotoreutus** ..... 389
**nyongii** ..... 390
Pristina leidyi n. c. ..... 171
Stephensoniana **tandyi** ..... 1
**Vomia** ..... 384
**prima** ..... 385

POLYCHAETA

Hermenia **neoverruculosa** ..... 242

ARTHROPODA

PYCNOGONIDA

Anoplodactylus compactus n. c. ..... 191

CRUSTACEA

Ascetocythere **bouchardi** ..... 7
**pseudolita** ..... 10
**triangulata** ..... 11
**veruta** ..... 12
Asellus (Asellus) **alaskensis** ..... 60
Atya **dressleri** ..... 51
Bathyconchoecia **diacantha** ..... 150
**hardingae** ..... 144
**Birubius** ..... 543
batei n. c. ..... 520
**panamunus** ..... 544
Calliasmata **rimolii** ..... 37
Chorisquilla **andamanica** ..... 258
excavata n. c. ..... 254
**pococki** ..... 256
Dactylocythere **crena** ..... 14
**scissura** ..... 15
Eurysquilla **pacifica** ..... 249
**Lirceolus** ..... 490
smithii n. c. ..... 490
Macrobrachium **crybelum** ..... 30
Orconectes **etnieri** ..... 459
**saxatilis** ..... 439
Parametopella **inquilinus** ..... 429
**Psittocythere** ..... 18
**psitta** ..... 18
Sarsiella **ozotothrix** ..... 497
Shiinoa **elagata** ..... 433

DIPLOPODA

**Exallostethus** ..... 212
**thrinax** ..... 212
Nannaria **domestica** ..... 186
**rutherfordensis** ..... 184
Polyzonium **laterale** ..... 377
**strictum** ..... 375

INSECTA

Watophilus **knowltoni** ..... 396

ECHINODERMATA

OPHIUROIDEA

Amphilimna valida n. c. ..... 134

## CHORDATA

### Pisces


Apogon **dispar** ..... 504
**melanoproctus** ..... 506
Corythoichthys **amplexus** ..... 271
**Eretmobrycon** ..... 332
**bayano** ..... 334
Glyphidodontops **springeri** ..... 347
Labidochromis **textilis** ..... 320
Percina **tanasi** ..... 473
Syngnathus **darrosanus** ..... 269


### Amphibia


Adenomera **lutzi** ..... 315
Eleutherodactylus **leucopus** ..... 351


### Reptilia


Aristelliger **hechti** ..... 308
Sphaerodactylus **thompsoni** ..... 369
Trophidophis nigriventris **hardyi** ..... 86
pilsbryi **galacelidus** ..... 81


### Mammalia


Tamandua mexicana n. c. ..... 104


### Fossil Aves


Milvago **alexandri** ..... 356

SMITHSONIAN INSTITUTION LIBRARIES

SMITHSONIAN INSTITUTION LIBRARIES

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01205 2072